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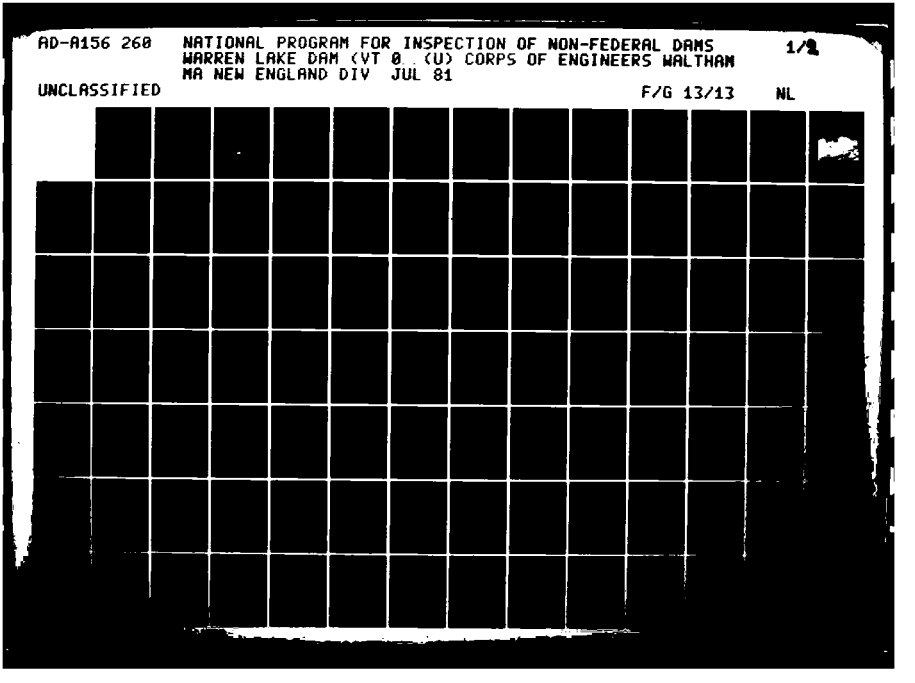

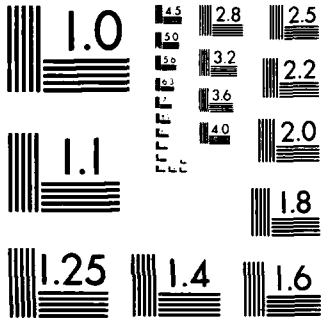

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RICHELIEU RIVER BASIN
WARREN, VERMONT

WARREN LAKE DAM

VT 00263

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02254

JULY 1981

REPRODUCED AT GOVERNMENT EXPENSE

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Richelieu River Basin
Warren VT.
Mills Brook

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a compacted earth embankment structure about 520 ft. long with a maximum height of 35 ft. The dam is judged to be in poor condition in its present state. It is intermediate in size with a high hazard potential. The test flood for the dam is the PMF. A number of recommendations are given for implementation by the owner within 1 yr. of receipt of the inspection report.

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WARREN L/ 'E DAM

VT 00263

RICHELIEU RIVER BASIN
WARREN, VERMONT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	VT 00263
Name of Dam:	WARREN LAKE DAM
Town:	WARREN
County and State:	WASHINGTON, VERMONT
Stream:	MILLS BROOK
Date of Inspection:	3 JUNE 1981

BRIEF ASSESSMENT

Warren Lake Dam is a compacted earth embankment structure approximately 520 feet long. The dam has a maximum hydraulic height of 35 feet. Top of dam storage capacity is 1780 acre-feet. The dam was estimated to be about 85% complete at the time of inspection. Construction began in 1980.

The purpose of the dam is to provide a 48-acre impoundment for private recreational use. When completed, the dam crest will serve as a relocated route for Town of Warren Highway No. 28 known as Plunkton Road.

The principal spillway is a 36-inch diameter corrugated metal pipe conduit with a 48-inch corrugated metal riser. There is a separate 24-inch diameter corrugated metal conduit which serves as a pond drain.

There is an emergency spillway made up of three 44-inch by 72-inch corrugated metal pipe arch culverts. The culvert bottoms are at an elevation 7 feet above the normal pool level. The top of dam is to be 15 feet above the normal pool level.

The dam is judged to be in poor condition in its present state. The visual observations made during the course of the inspection revealed deficiencies including erosion gullies, particularly at the contacts between the embankment and abutments, soft and wet areas at the downstream toe, poor concrete work and deflections in pipe walls.

Because the dam has an intermediate size and a high hazard potential classification, the test flood is the Probable Maximum Flood (PMF). The test flood inflow for Warren Lake which has a drainage area of 0.93 square miles was estimated to be 2325 cfs.

Effects of surcharge storage would reduce the test flood inflow to a routed test flood outflow of about 360 cfs. Assuming the lake is at its normal pool elevation (1550 NGVD) at the start of the flood, water would rise to a level of 4.8 feet below the top of dam under test flood conditions. Spillway capacity at the top of dam is 760 cfs which is 210% of the routed test flood outflow.

A number of recommendations are given for implementation by the owner within 12 months from receipt of this Phase I Inspection Report. These recommendations, in general, are as follows:

Retain a qualified Registered Professional Engineer to:

- Make a reassessment of the entire project from a design standpoint.

- Investigate the 36-inch and 24-inch conduits and design instrumentation and establish methods and schedules for monitoring possible seepage along the conduits.

- Investigate and design repairs for soft and wet areas at the downstream toe.

- Design methods to repair erosion gullies and methods to prevent recurrence of these gullies.

- Reevaluate the mechanical apparatus for the 24-inch drain conduit with respect to potential for plugging with debris and damage by ice.

- Establish methods and schedules for monitoring flows from the toe drains.

- Investigate the hydraulic adequacy of the emergency spillway approach and discharge channels and design repairs.

- Investigate the structural stability and design repairs to the concrete work for the emergency spillway culverts.

- Investigate and design repairs to the outlet structure for the 36-inch conduit.

- Investigate the adequacy of riprap on the upstream slope.

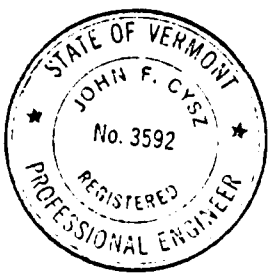
- Supervise completion of the dam and record all as-built information and foundation conditions.

- Establish procedures for filling of the lake and supervise filling of the lake after construction and all repairs are complete.

The owner should carry out all the recommendations made by the engineer. All work should be done under the supervision of the engineer.

The owner should also implement the maintenance program which has been established as part of the design for this dam. In addition, the owners should clear the main discharge channel and the emergency discharge channels, grade disposal areas, monitor seepage flows, and establish a formal written program for surveillance and downstream warning.

A qualified Registered Professional Engineer should be engaged to make a comprehensive technical inspection of the dam and dike once a year.



John F. Cysz
Project Manager
VT P.E. No. 3592

Warren Lake Dam

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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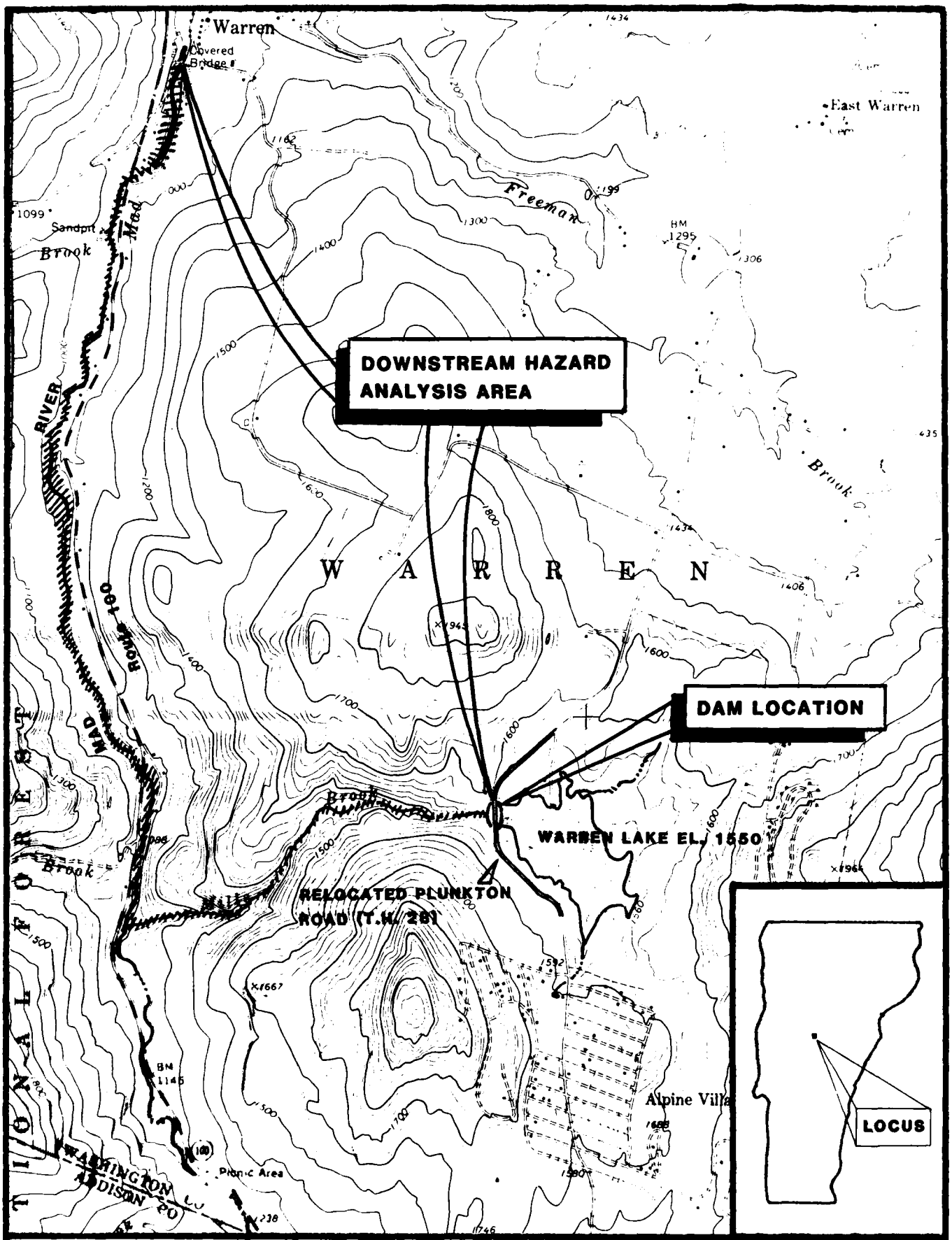
OVERVIEW OF WARREN LAKE DAM

Looking towards the dam from upstream.



WARREN LAKE DAM

WARREN, VERMONT

Identification No. VT. 00263

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LOCATION PLAN

Warren Quadrangle

1:24000

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
WARREN LAKE DAM
SECTION I
PROJECT INFORMATION

1.1 GENERAL

a. Authority

Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Robert G. Brown & Associates, Inc. has been retained by the New England Division to inspect and report on selected dams in the Commonwealth of Massachusetts and State of Vermont. Authorization and notice to proceed were issued to Robert G. Brown & Associates, Inc. under a letter of 23 October 1980 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract Number DACW33-81-C-0004 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 DESCRIPTION OF PROJECT

a. Location

Warren Lake Dam is located in the Town of Warren, Vermont. The dam is on Mills Brook, 1.1 miles upstream of the brook's confluence with Mad River. The dam site is located on the USGS Warren, VT Quadrangle at latitude N44° 04.5' and longitude W72° 50.0'. Access to the site is by Plunkton Road (Town of Warren Highway No. 28).

b. Description of Dam and Appurtenances

Warren Lake Dam is a compacted earth embankment structure, approximately 520 feet long with a maximum hydraulic height of 35 feet. The long axis of the dam is oriented in a north/south direction. At the time of this inspection, construction of the dam was approximately 85% complete.

The crest of the dam is designed to have a width of about 30 feet and will serve as a roadway for the relocated route of Plunkton Road. Both the downstream and upstream faces have slopes of 3H to 1V. There is an earth key trench designed to be a minimum of 4 feet deep into the dam foundation.

The principal spillway consists of a 36-inch diameter asphalt coated corrugated metal pipe (ACCMP) about 190 feet in length through the embankment. There is a concrete end wall at the outlet of the 36-inch conduit (see Appendix C, Photograph 8). There are steel anti-seep collars on this conduit. There is a 48-inch diameter corrugated metal pipe riser connected to the upstream end of the conduit with a prefabricated tee (see Appendix C, Photograph 3). The crest of the riser is designed to be set at elevation 1550 NGVD. At the time of the inspection, the riser was not complete; however, the design plan calls for the riser to have a trash rack and anti-vortex device, plus a 1" diameter trickle flow outlet, and a 24-inch diameter shear gate to allow the lake level to be adjusted to elevation 1545 NGVD. The invert of the 36-inch conduit is designed for elevation 1541 NGVD. The design top of dam elevation is 1565 NGVD.

Approximately 15 feet to the south of the 36-inch conduit there is a 24-inch ACCM pipe about 240 feet in length which also passes through the embankment (see Appendix C, Photograph 3). There are steel anti-seep collars on the 24-inch conduit. The purpose of the conduit is to provide a means for complete draining of the lake. The design elevation for the inlet of the drain is 1536 NGVD.

At the time of this inspection there was no valve or operating mechanism for the drain. However, the plan calls for a 24-inch mud valve to be installed on the conduit. Originally the design called for a slide gate valve. The mud valve is to be operated by a steel shaft of unspecified diameter approximately 60 feet long. The shaft is to be encased in a galvanized pipe housing supported by treated timber posts with maximum spacing of 8 feet. The timber posts are to be embedded in the upstream slope of the embankment. The plan calls for a reinforcing bar trash screen around the inlet to the 24-inch drain. This is shown on Sheet 4A of Design Plans with supplemental revision in Appendix B.

Approximately 320 feet south of the 36-inch conduit there is an emergency spillway made up of three 44-inch by 72-inch corrugated metal pipe arch culverts with a concrete headwall and endwall (see Appendix C, Photographs 9 through 12). The three culverts are designed to have 8-inch thick concrete cutoff walls into ledge at mid-length. The design plans originally called for the emergency spillway to be three 6-foot by 10-foot reinforced concrete box culverts. The inverts of the inlets for the three pipe arch culverts are designed to be at elevation 1557 NGVD. The emergency spillway flow is directed to the culverts by an excavated approach channel which was incomplete at the time of inspection (see Appendix C, Photograph 10). The discharge from the emergency spillway is conveyed to the downstream channel through an excavated channel with an earthen berm on the downhill side (see Appendix C, Photograph 13). The emergency spillway discharge channel was incomplete at the time of inspection.

At the downstream toe of the dam, on either side of the outlet for the 24-inch conduit, there are two 6-inch diameter PVC drain pipes (see Appendix C, Photograph 8). These PVC pipes collect water from a gravel toe drain which reportedly extends a maximum of 80 feet upstream of the toe of dam. The design plan shows the gravel toe drain as being 1 foot in thickness and wrapped in filter fabric (see Design Plans, Sheets 3R and 4 in Appendix B). At the ends of the 6-inch PVC drains there are 6-inch PVC cleanout risers. There are two 2-foot wide gravel trench drains wrapped in filter fabric which extend from the gravel toe drain to both abutments.

The road base for Plunkton Road is to consist of 6 feet of gravel placed between elevation 1559 NGVD and the top of dam elevation 1565 NGVD. A compacted earth blanket will cover the gravel on the upstream slope of the dam (see Design Plans, Sheet 4 in Appendix B). This blanket has not been constructed to date. A riprap blanket is called for at the normal pool elevation on the upstream slope. The upstream riprap blanket is incomplete (see Appendix C, Photograph 2).

Riprap is also called for on the downstream slope above elevation 1559 NGVD. This riprap is not in place.

c. Size Classification

The size classification of this dam is Intermediate according to criteria set forth in Recommended Guidelines for Safety Inspection of Dams by the Corps of Engineers. The dam has a top of dam storage of 1780 acre-feet (within the range of 1,000 to 50,000 acre-feet storage), and a maximum hydraulic height of 35 feet. The size classification is based on the storage criteria.

d. Hazard Classification

The dam is in a high hazard category because a major breach of the dam could cause a large amount of property damage and the loss of more than a few lives. The Village of Warren, Vermont is located about 18,000 feet downstream of the damsite. There are 6 to 12 structures which could be flooded by 2 to 10 feet of water as a result of a major breach of the dam. Prior to the breach, water would be about 10 feet below the lowest structure (see Section 5.5).

e. Ownership

The dam is presently owned by a partnership of Lenord Robinson of Warren, Vermont 05674, Telephone (802) 496-3788, and Jack C. Keir of 481 Brookwood Road, Wayne, PA 19087, Telephone (215) 688-9028. Upon completion of the project, ownership of the dam and lake will be vested in a landowner's association. The Town of Warren will have an easement over the dam in order to relocate Plunkton Road.

f. Operator

All activities at the damsite are presently supervised by:

Lenord Robinson
Warren, Vermont 05674
Telephone: (802) 496-3788

g. Purpose

The dam will impound a 48-acre lake which will be used for private recreation. When completed, the dam crest will serve as a relocated route for Town of Warren Highway No. 28 (Plunkton Road).

h. Design and Construction History

The design of Warren Lake Dam is described in a document entitled "Analysis and Design of a Private Recreational Pond for Jack C. Keir and Lenord Robinson, Warren, Vermont" dated Rev. December 1979. (See Appendix B.)

The design of the dam is shown on a set of plans as follows:

Sheet	Date
SP-1	Rev. Dec. 1979
1	August 1979
2	August 1979
3	Rev. Dec. 1979
3R (Alt. #2)	August 5, 1980
4	Rev. Feb. 10, 1980
4A	Rev. Feb. 10, 1980
5	Rev. Dec. 1979

There is a supplemental sheet No. 4A dated June 30, 1980 which shows a revised pond drain (mud valve type). Specifications for the dam have revision dates of December 1979 and February 18, 1980.

The dam was designed by James P. Olsen, P.E. of Hinesburg, Vermont.

As part of the design, 3 soil borings were made to depths of 24 feet, 18.5 feet and 37 feet. The borings were made by Green Mountain Boring Company Inc. of Barre, Vermont between October 18 and October 23, 1979. Copies of the boring logs are included in Appendix B. Boring locations are shown on the design plans.

The maximum depth of rock cored in any of the 3 borings was 2 feet. All three borings were at the north end of the dam. One of the borings (SB2) encountered what appeared to be loose gravel. This condition was judged on the basis of further test pits to be an anomaly. (A reportedly isolated area of sand and gravel was also later found during construction in a borrow area on the south side of the valley section about 250 feet upstream of the southerly abutment.)

In addition to the 3 borings a series of test pits were excavated. Logs of the test pits are included in the design report (see Appendix B). Locations of the test pits are shown on the plans.

The design study included a stability and seepage analysis; laboratory testing of soil permeability; a compaction test on a composite sample of borrow material; and grain size analyses of borrow materials. No permeability tests were made in the dam foundation.

Construction of the dam began in early July 1980. The contractor was Lenord Robinson Building and Excavating Contractors of Warren, Vermont. No unusual or unforseen problems were reported during construction except that the gravel toe drain was replaced because the gravel fill became contaminated with fines.

A cofferdam and the 24-inch ACCM conduit were used to control water during construction of the dam. The key trench was excavated after the installation of the 24-inch conduit. The 36-inch ACCM conduit was then installed. Both the 24-inch and the 36-inch conduits are reported to have been placed on natural soil and backfilled with compacted earth. Both the 36-inch and the 24-inch conduits were provided with metal anti-seep collars. The collars, pipe, and riser tee were fabricated by Northeast Culvert Corp. of Westminster, Vermont. The size of the fabricated collars for the 24-inch conduit was smaller than the size called for on the design plans. The contractor installed an extra collar to compensate for the dimensional difference.

Approximately 26,000 cubic yards of earth fill was used to construct the dam to its present condition.

The design engineer made about 12 in-place density tests, using nuclear technique, at various locations in the embankment. There are no records of in-place density tests made within the zone of backfill for the 24-inch conduit.

Most of the borrow material was excavated from an area just upstream of the northerly abutment. The specifications called for earth fill to be compacted to at least 95% of Standard Proctor Density. The one laboratory compaction test indicated the maximum dry density (Standard Proctor Test) was 127 pcf at 10% moisture content.

The emergency spillway was constructed using three 44-inch by 72-inch corrugated metal pipe arches with concrete headwalls instead of the reinforced concrete box culverts originally planned. There are no reports of concrete tests made on any of the concrete used at the dam.

The emergency spillway approach channel and discharge channel have not yet been excavated to the dimensions indicated on the design plans because of rock encountered during construction.

Construction on the dam was suspended in November of 1980 and, as of the time of this inspection, there has been no significant construction activity since that date.

Currently a portion of the proposed pond area is being excavated to remove organic deposits which are being marketed for sale by the owners.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area consists of 0.93 square miles of wooded, mountainous terrain. The entire watershed lies within the Town of Warren. The watershed has a long axis of about 6000 feet oriented in a northerly direction. Several natural drainage swales enter along the area which will be flooded by the dam. Elevations in the watershed range from 1960 NGVD at the easterly boundary to 1530 NGVD at the toe of the dam.

b. Discharge at Damsite

Discharge at the damsite is through a principal spillway made up of a 36-inch diameter asphalt coated corrugated metal (ACCM) conduit with a 48-inch diameter ACCM riser. The riser crest will maintain a normal pool at elevation 1550 NGVD. A 24-inch shear gate will be installed to allow the pool to be lowered to elevation 1545 NGVD. A 1-inch diameter hole in the side of the riser at elevation 1545 NGVD will provide a trickle flow during dry weather should the lake level fall below the riser crest.

(1) Outlet Works - 36-inch diameter ACCM conduit with 48-inch ACCM riser crest at 1550 NGVD. Capacity is 127 cfs with water at 1565 NGVD. Capacity of 24-inch diameter ACCM pond drain is 47 cfs with water at 1565 NGVD.

(2) Maximum Flood at Damsite - Dam has not impounded water.

(3) Ungated Spillway Capacity at Top of Dam - Combined capacity of three 44-inch by 72-inch corrugated metal culverts plus 36-inch conduit is 757 cfs with water at 1565 NGVD.

(4) Ungated Spillway Capacity at Test Flood Elevation - 360 cfs at 1560.2 NGVD.

(5) Gated Spillway Capacity at Normal Pool Elevation - not applicable.

(6) Gated Spillway Capacity at Normal Pool Elevation - not applicable.

(7) Total Spillway Capacity at Test Flood Elevation - 360 cfs at 1560.2 NGVD.

(8) Total Project Discharge at Top of Dam - 757 cfs at 1565 NGVD.

(9) Total Project Discharge at Test Flood Elevation - 360 cfs at 1560.2 NGVD.

c. Elevation (feet above NGVD based on datum of construction plans)
(1) Streambed at Toe of Dam - 1530 NGVD.

(2) Bottom of Cutoff - unknown. Minimum of 4' depth into foundation called for on construction plans.

(3) Maximum Tailwater - unknown.

(4) Normal Pool - 1550 NGVD (at principal spillway crest).

(5) Full Flood Control Pool - not applicable.

(6) Principal Spillway Crest - 1550 NGVD.

(7) Design Surcharge - 1561.9 NGVD. (Original Design assumes no outflow.)

(8) Top of Dam - 1565 NGVD.

(9) Test Flood Surcharge - 1560.2 NGVD.

d. Reservoir (length in feet)
(1) Normal Pool - 2600 feet.

(2) Flood Control Pool - not applicable.

(3) Principal Spillway Crest Pool - 2600 feet.

(4) Top of Dam - 2800 feet.

(5) Test Flood Pool - 2700 feet.

e. Storage (acre-feet)
(1) Normal Pool - 360.

(2) Flood Control Pool - not applicable.

(3) Principal Spillway Crest Pool - 360.

(4) Top of Dam - 1780.

(5) Test Flood Pool - 1150.

f. Reservoir Surface (acres)
(1) Normal Pool - 48.

(2) Flood Control Pool - not applicable.

(3) Principal Spillway Crest Pool - 48.

(4) Top of Dam - 150.

(5) Test Flood Pool - 110.

g. Dam

(1) Type - Compacted earth embankment.

(2) Length - 520 feet.

(3) Height - 35 feet.

(4) Top Width - 30 feet.

(5) Side Slopes - 3H to 1V both upstream and downstream.

(6) Zoning - gravel fill above elevation 1559 NGVD with compacted earth blanket on upstream slope. Gravel drain at downstream toe.

(7) Impervious Core - no special core, homogeneous fill.

(8) Cutoff - earth key trench.

(9) Grout Curtain - none.

h. Diversion and Regulating Tunnel - not applicable.

i. Principal Spillway

(1) Type - 36-inch diameter ACCMP conduit with 48-inch ACCMP riser.

(2) Length of Weir - 12.6 feet circumference of riser weir.

(3) Crest Elevation - principal spillway riser crest at 1550 NGVD.

(4) Gates - one 24-inch shear gate on riser, gate invert at 1545 NGVD.

(5) U/S Channel - riser for principal spillway is embedded in embankment and has no approach channel other than pond.

(6) D/S Channel - Mills Brook.

j. Emergency Spillway

(1) Type - three 44-inch by 72-inch corrugated metal pipe arch culverts.

(2) Length of Weir - 18 feet combined base width of pipe arch culverts.

(3) Crest Elevation - culvert inverts at 1557 NGVD.

(4) Gates - none.

(5) U/S Channel - excavated channel through earth and rock approximately 150 feet long by minimum 12 feet wide.

(6) D/S Channel - culverts discharge to excavated channel through earth and rock about 300 feet long by 10 to 15 feet wide with 6-foot high earthen berm on the downhill side. Channel discharges to natural wooded area above Mills Brook.

k. Regulating Outlets

(1) Invert - 1536 NGVD.

(2) Size - 24 inches diameter.

(3) Description - ACCM drain conduit.

(4) Control Mechanism - mud valve (not in place) operated by gate stem supported by timber posts in upstream slope.

(5) Other - 24-inch shear gate with invert at 1545 NGVD in riser crest for purpose of lowering pool.

SECTION 2
ENGINEERING DATA

2.1 DESIGN DATA

Complete design data are maintained in the files of the design engineer James P. Olsen, P.E., of Hinesburg, Vermont. The design of Warren Lake Dam is described in a document entitled "Analysis and Design of a Private Recreational Pond for Jack C. Keir, and Lenord Robinson, Warren, Vermont" dated Rev. December 1979. Design plans and specifications are described in Section 1.2h.

2.2 CONSTRUCTION DATA

Construction records are maintained in the files of the design engineer. Records of inspection by the State of Vermont are on file with the Vermont Water Resources Board. There are no as-built plans available to date.

Construction Progress Reports were prepared by the design engineer twice a month during 1980 construction and submitted to the Vermont Department of Water Resources. The State Dam Safety Inspector also made periodic visits to the site during construction. These reports are on file with the Vermont Department of Water Resources. Copies of selected reports are attached in Appendix B.

No in-place density tests were made during construction around the 24-inch ACCM conduit and no strength tests were made on any of the concrete work.

2.3 OPERATION DATA

The dam has not impounded water and as such has not been operated to date. Construction is approximately 85% complete.

2.4 EVALUATION OF DATA

a. Availability

Design and construction data including plans and specifications were made available by the design engineer.

b. Adequacy

The final assessments and recommendations of this investigation are based primarily on the visual inspection and hydrologic and hydraulic calculations made as part of the inspection report.

c. Validity

The engineering data provided by the design engineer have been deemed adequate for the purpose of this Phase I inspection. This investigation did not include a detailed engineering check of design calculations.

SECTION 3
VISUAL INSPECTION

3.1 FINDINGS

a. General

Warren Lake Dam was inspected on June 3, 1981. The weather was clear at the time of inspection. Water was flowing through the 24-inch diameter drain at a depth of 3 inches (estimated flow of about 1 cfs). There is no valve at the end of the drain conduit. The dam was impounding no water (see Appendix C, Photograph 2).

Construction on the dam was suspended in November 1980. The dam is incomplete and has never impounded water.

During the inspection, the owner indicated that the planned permament pool elevation of 1550 NGVD will be lowered to 1548 NGVD; however, there has been no official proposal on this matter. This inspection report is based on the approved normal pool elevation of 1550 NGVD.

The 36-inch conduit was observed from the interior. The interior of the 24-inch conduit could not be viewed.

b. Dam

(1) Crest - As of the date of this inspection, the crest of the dam is at approximately elevation 1563.5 NGVD. The design top of dam is at elevation 1565 NGVD, but is to be constructed with a camber to allow for settlement. The existing crest width is approximately 25 feet near the dam center because the compacted earth blanket on the upstream slope has not been constructed. The crest is designed to be 30 feet wide with the compacted earth blanket. The existing crest is roughly graded. There are wheel tracks about 4 inches deep in the crest (see Appendix C, Photograph 1). No surface cracks were observed in the crest. There are random erosion gullies up to 4 inches deep along the edges of the existing crest.

(2) Upstream Slope - The upstream slope has hay mulch and is sparsely vegetated with rye grass. The upstream slope above elevation 1559 NGVD has not been completed. (This is the compacted earth blanket noted in the previous paragraph.) There are random erosion gullies up to 10 inches in depth on the upstream slope. There is no material on the slope which resembles topsoil. The riprap at the normal pool level is about 60 percent complete. The stone size varies between about 6 inches and 10 inches. The riprap appears to be thin, hand placed in one layer on top of the compacted earth embankment. There is no visible evidence of a filter blanket or bedding beneath the riprap.

An 8 to 12-inch deep gully was observed around the 48-inch riser pipe.

There is a stone lined swale on the upstream slope at the contact with the northerly abutment. This lined swale ends at about the normal pool.

A pile of jagged rock fragments and solid rock outcropping is located where the upstream slope contacts with the southerly abutment in the area of the excavation for the emergency spillway approach channel (see Appendix C, Photograph 10).

No evidence of sloughing or mass soil movements on the upstream slope was noted.

(3) Downstream Slope - The downstream slope has hay mulch and is sparsely vegetated with rye grass. There are random erosion gullies up to 6-inches deep. An 18-inch deep erosion gully exists at the contact with the northerly abutment (see Appendix C, Photograph 4). There is a ½ gpm seep at the end of this gully. This gully has caused a washout at the ends of the 36-inch and 24-inch conduits (see Appendix C, Photograph 7 and 8) exposing the pipes.

The backfill for the dry laid stone endwall for the 24-inch drain is washed out. The owner has constructed a temporary dike at the north abutment to divert water away from this gully.

A 12-inch deep gully exists at the contact with the southerly abutment (see Appendix C, Photograph 5) and along the southerly downstream toe. There is standing water in this gully which appears to be seepage from the southerly abutment area.

Approximately 180 feet south of the 36-inch conduit, along the downstream toe of the dam, there is a 3-foot wide by 10-foot long area which is soft, spongy, and appears to indicate a quick condition (see Appendix C, Photograph 6). Since the dam is not impounding water, this condition is probably the result of a spring which has not been intercepted by the dam's foundation drainage system.

No evidence of sloughing or mass soil movements on the downstream slope was observed. The top of the downstream slope is gravel fill for the proposed Plunkton Road relocation.

c. Appurtenant Structures

(1) Foundation Drainage System - The two 6-inch PVC outlets for the foundation drain were visible. The ends of the two pipes are deformed where they pass through the dry laid stone endwall for the

24-inch drain (see Appendix C, Photograph 8). Small animal guards for these pipes are called for on the design plans but are not in place. The southerly 6-inch outlet had a 1 quart per minute flow of clear water. The northerly 6-inch outlet had a 1 pint per minute flow of clear water. There is rust color slime at the ends of both 6-inch outlets. The bottom of the northerly outlet is 2 to 3 inches above the 24-inch drain. The southerly outlet is about ½ inch lower than the 24-inch drain.

There are two 6-inch solid PVC cleanout risers on the downstream slope. These risers mark the ends of the 6" PVC foundation drain pipes. The northerly and southerly pipes extend above the embankment 5.8 feet and 1.2 feet respectively.

The gravel blanket toe drain is reported by the design engineer to extend a maximum of 80 feet upstream from the downstream toe. The limits of the gravel trench drains could not be determined on the basis of observation. It is not known if the trench drains extend to the 3' x 10' soft area noted in paragraph 3.1b(3). The engineer reports that one spring in the southerly abutment was encountered during construction.

(2) Principal Spillway - The 36-inch diameter conduit was observed from the interior between the downstream end and a point about 60 feet downstream of the 48-inch riser. The pipe is asphalt coated corrugated steel. There is a bent pipe end at a joint about 40 feet upstream from the outlet. There is rust color seepage at a pipe joint about halfway between the ends of the 36-inch conduit. (This water could be caused by condensation.) The flow at the end of the 36-inch conduit was judged to be about ¼ pint per minute.

Within a length of about 75 feet downstream of the 48-inch riser, there are 3 low areas in the bottom of the 36-inch conduit which have an accumulation of silt. The base of the 48-inch riser is concrete. The anti-vortex device trash rack and sheargate are not in place. There are no ladder rungs in the riser.

At the downstream end of the 36-inch conduit there is a concrete endwall (see Appendix C, Photograph 8). The endwall also forms a discharge apron. Wood formwork is embedded in the concrete. The wingwalls for the structure have rough and honeycombed concrete. The bottom of the 36-inch conduit is about 2 inches above the concrete discharge apron instead of the 2 feet shown on the design plans.

(3) Pond Drain - The 24-inch drain conduit is open and is passing the full flow of Mills Brook. The flow in the conduit was estimated at 1 cfs at the time of inspection. The interior of the 24-inch conduit was not visible. There is no valve or operating mechanisms on the upstream end of the conduit (see Design Plans, Sheet 4A in Appendix B). The 24-inch conduit presently projects about 5 feet beyond the upstream toe (see Appendix C, Photograph 3). At the downstream end of the 24-inch conduit, there is a dry laid stone endwall (see Appendix C, Photograph 8). A portion of the backfill for this wall is washed out. The end of the 24-inch conduit is about 3 feet upstream of the end of the 36-inch conduit. The design plans show the 24-inch extending further downstream.

(4) Emergency Spillway - The emergency spillway is made up of three 44-inch high by 72-inch wide corrugated steel arch culverts. The steel appears to be galvanized (see Appendix C, Photograph 9). The concrete walls at both the upstream and downstream ends of the culverts are of irregular width, (between 5 and 8 inches wide), roughly formed, and have approximately vertical cracks about ¼-inch wide at the top of each culvert (see Appendix C, Photographs 10, 11, and 12). The buttresses on the downstream wall have no footings. The upper portions of tne walls are not backfilled. There is up to about 2 inches of deflection in the tops of the culverts (see Appendix C, Photograph 11). It is not known if the cutoff collar for the culverts was installed.

The shapes and layout of both the approach channel and discharge channel for the emergency spillway vary from the design plan (see Appendix C, Photographs 10 and 13). Rock mass is visible in the sides of both channels.

The existing emergency spillway approach channel has a width of about 12 feet at a point 80 feet upstream of the inlets to the emergency spillway culverts. The design plan calls for a width of 60 feet at this point. Rock is exposed in the sides of the approach channel. The owner reports that this rock cannot be excavated without blasting.

Trees are growing adjacent to the emergency spillway discharge channel. Several trees have fallen across the channel. An earth dike along the north side of the discharge channel has not been constructed as of this inspection. This dike is necessary to prevent emergency spillway flow from being directed towards toe of the dam. The existing emergency spillway discharge channel has a bottom width of about 12 feet and 3H to 1V side slopes except that the channel has steeper side slopes where it is in rock cut. The discharge channel called for on the design plans varies in width from 35 feet at the dam to 85 feet at a point 400 feet downstream of the dam.

There is a 15-inch diameter corrugated metal culvert (see Appendix B) which discharges into the emergency spillway approach channel. This culvert collects water from a slope area downstream of the dam. The culvert was flowing at about 5 gpm.

d. Reservoir Area

With the lake at its normal pool elevation 1550 NGVD, the dam will impound a lake having a surface area of about 48 acres. There are no structures along the shoreline. Plunkton Road (see Location Map) is to be relocated so as to pass over the dam.

The owner is currently excavating organic deposits from the pond area.

e. Downstream Channel

The 36-inch diameter principal spillway and the 24-inch diameter pond drain discharge directly to Mills Brook.

The emergency spillway discharges to a 300-foot long excavated channel (see Appendix C, Photograph 13) which directs flow to a wooded slope about 15 feet above and 100 feet from Mills Brook at a point about 100 feet downstream of the toe of the dam.

There are some dead trees along the main channel of Mills Brook downstream of the dam (see Appendix C, Photograph 7).

3.2 EVALUATION

The Phase I visual inspection of Warren Lake Dam indicates that the dam is about 85% complete. The dam is judged to be in poor condition in its present state. The visual inspection revealed deficiencies which if not remedied, have the potential for developing into hazardous conditions.

The dam has not impounded water to date, therefore deficiencies may not have been visible during the inspection which might otherwise be detected if the dam was inspected under full impoundment conditions.

The following are areas of specific concern:

- The corrugated metal conduits are bedded and backfilled with earth. There is a concern that complete filling of the voids beneath the corrugated pipe cannot be accomplished with this type of construction. (Note that conduits through earth dams having operating heads similar to this dam are commonly laid on concrete cradles.) There are low areas in the bottom of the 36-inch conduit which could have been caused by poor support. There are no records of compaction tests made adjacent to the 24-inch conduit. Water could travel through voids along the pipe. A method should be designed to determine if seepage along the conduits is occurring. Leakage through pipe joints could aggrevate this condition. The hydraulic appurtenances for the 48-inch riser should be installed before the spillway is allowed to operate.

- The compacted earth blanket on the upstream slope above elevation 1559 NGVD should be constructed since leakage or piping through the gravel crest could occur if water in the lake rose above this elevation.

- The erosion gullies on both the upstream and downstream slopes, and at the contacts with abutments have caused loss of embankment materials. These areas should be properly excavated and refilled with compacted earth. A method of surface water control should be designed to prevent the gullies from recurring. The slopes of the dam should be vegetated with a grass type which protects against erosion but which will not obscure conditions of the slopes during inspections.

- The mechanical apparatus for the 24-inch drain conduit is not in place. Before the equipment is installed the proposed mechanisms should be reevaluated to determine the potential for plugging by debris. Also the operating mechanisms should be reevaluated to determine the potential for damage by ice. Sizes and material types for the operating shafts should be determined.

- The 3-foot by 10-foot area displaying quick conditions at the southerly downstream toe requires further study to determine a method of repair. A study of the adequacy of the existing drainage system should be made to assess if this quick area and the wetness of the downstream toe in general can be eliminated by improvements or enlargement of the exisitng drainage system. Seepage flows from the toe drain should be monitored and recorded both before and after filling of the lake so that quantities of flows from springs in the abutments can be differentiated from seepage flows through the embankment. The ends of the drain outlets should be repaired or replaced by pipes which will not deflect, and small animal guards installed. The tops of the cleanout risers should be adjusted to final grade and capped.

- The hydraulic adequacy of the emergency spillway approach discharge channels should be investigated to assess the need to enlarge the channels. Rock excavation by blasting in the area of the dam could cause damage to the dam and its foundation.

- The cracks in the headwall and endwall for the emergency spillway culverts are evidence of wall movements. The walls appear unstable and require repairs or replacement. The concrete work is rough and there are areas where the concrete is honeycombed. The causes and repairs to the deformations of the culvert walls should be investigated since the culverts will also provide structural support for the road above.

- The rough concrete work for the outlet structure of the 36-inch principal spillway and the embedded formwork could lead to early failure of the structure. This structure should be investigated and repairs designed as necessary including the repair of eroded backfill.

- The riprap on the upstream slope is not complete and does not appear to be bedded in materials which will protect against loss of embankment materials and undermining of the riprap.

- The dike on the north side of the emergency spillway discharge channel is required to prevent emergency overflows from flowing towards the downstream toe of the embankment.

SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 OPERATIONAL PROCEDURES

a. General

The dam is approximately 85% complete and has not impounded water. Upon completion of the project, maintenance of the pond and the dam will be vested in a landowner's association. Each member of the association will own a portion of the lake/embankment and will be assigned continuing responsibility for maintenance during their ownership period. The maintenance responsibility will be a deed covenant to be continually transferred with land ownership. Since the crest of the dam will be utilized for the relocation of Plunkton Road, an agreement with the Town of Warren is being formalized regarding mutual responsibilities for maintaining that portion of the structure which will serve as the road.

b. Description of any Warning System in Effect

There is no written surveillance or warning system in effect or planned.

4.2 MAINTENANCE PROCEDURES

a. General

A formal maintenance plan has been established for this project. The plan is described in an undated document entitled "Warren Lake - Maintenance Procedures", which lists ten routine maintenance procedures. A copy of this document is attached in Appendix B.

b. Operating Facilities

The riser crest of the principal spillway will maintain the normal pool at elevation 1550 NGVD. The design plan calls for a 24-inch shear gate to allow the level to be lowered and maintained at elevation 1545 NGVD. (This shear gate was not in place at the time of this inspection.) There is a 24-inch conduit which is designed to completely drain the lake. The control valve for this drain is designed to be placed on the upstream end of the conduit. The established maintenance plan calls for this valve to be exercised at least annually. This valve was not in place at the time of this inspection.

The emergency spillway requires no operation except that the approach channels and discharge channels are to be kept clear. The established maintenance plan calls for snow to be removed from the emergency spillway in order to provide free water flow at all times. It is not clear whether this item is a maintenance responsibility of the Town or an operational responsibility of the owners.

4.3 EVALUATION

The written maintenance plan has been established for this project. The owners should implement the plan and periodically review it to determine if it requires modification. The owner should retain a qualified Registered Professional Engineer to make annual technical inspections. Initial filling of the lake should be under the supervision of the engineer.

A formal written surveillance and downstream warning (emergency preparedness) plan should be established for this structure.

The responsiblity for keeping the emergency spillway clear of snow should be clarified.

SECTION 5
EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 GENERAL

The drainage area consists of 0.93 square miles of wooded, mountainous terrain. The entire watershed lies within the Town of Warren. The watershed has a long axis of about 6000 feet oriented in a northerly direction. Several natural drainage swales enter along the area which will be flooded by the dam.

Elevations in the watershed range from 1960 NGVD at the easterly boundary to 1530 NGVD at the toe of the dam.

5.2 DESIGN DATA

Hydraulic and Hydrologic design data for this project are included in a document entitled "Analysis and Design of a Private Recreational Pond for Jack C. Keir and Lenord Robinson, Warren, Vermont"; having a revised date of December 1979 (see Appendix B). The dam was designed for a maximum high water elevation 1561.9. Hydrologic methods of the U.S. Department of Agriculture Soil Conservation Service were used in the design.

5.3 EXPERIENCE DATA

The dam is not complete and has not impounded water to date.

5.4 TEST FLOOD ANALYSIS

Warren Lake Dam is classified as intermediate size having a maximum hydraulic height of 35 feet and a top of dam storage of 1780 acre-feet. The dam was determined to have a high hazard classification. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood is the Probable Maximum Flood (PMF).

The Probable Maximum Flood was estimated using methods contained in "Preliminary Guidance for Estimating Maximum Probable Discharges in Phase I Dam Safety Inspections" issued by the New England Division Corps of Engineers. The curve for mountainous terrain was used in this estimate.

The PMF test flood inflow from 0.93 square mile drainage area was estimated to be 2325 cfs (2500 CSM). Storage effects would reduce the test flood inflow to a routed test flood outflow of approximately 360 cfs.

During test flood conditions water would rise to elevation 1560.2 which is about 4.8 feet below the design top of dam. Water would be passing through the emergency spillway at a depth of 3.2 feet and at a flow rate of 240 cfs. Spillway capacity at the top of dam (1565 NGVD) is 760 cfs which is 210 percent of the routed test flood outflow.

This analysis assumes that the lake is at elevation 1550 NGVD at the start of the test flood and that the 24-inch drain conduit is closed.

5.5 DAM FAILURE ANALYSIS

The impact of failure of the dam was assessed using Corps of Engineers "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs". The estimate assumes:

a. the reservoir surface is at the test flood elevation (1560.2 NGVD) at the time of the breach, and

b. a breach of 40% of the dam length at mid-height occurs (104 feet).

The estimated initial discharge resulting from the breach would be approximately 29,000 cfs.

Immediately downstream of the dam the breach flow would be contained within the valley section of Mills Brook. There presently is no development along Mills Brook. About 6000 feet downstream of the dam the breach flow would enter the Mad River which flows in a northerly direction.

Approximately 8300 feet downstream of the dam, Mad River crosses Route 100 beneath a steel stringer bridge. There are 2 or 3 structures in the area of this bridge which could be flooded by 2 or 3 feet of water. Prior to the breach, the water would be about 20 feet below the level of these structures.

Approximately 18,000 feet downstream of the dam, Mad River flows through the Village of Warren. There are between 6 and 12 structures which could be flooded by 2 to 10 feet of water. Prior to the breach, water would be about 10 feet below the lowest structure.

Because of the potential for a large amount of property damage and the possible loss of more than a few lives, Warren Lake Dam was classified as High Hazard.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 VISUAL OBSERVATIONS

The dam has not impounded water to date, therefore deficiencies may not have been visible during the inspection which might otherwise be detected if the dam was inspected under its full impoundment conditions.

The most significant visual observations regarding the structural stability are the following:

(1) The corrugated metal pipe conduits pose unique problems with soil compaction, particularly along the lower half of the pipe. The corrugations make it difficult to fill all voids beneath the pipe with compacted earth. This can cause settlements in the pipe and can lead to seepage of water along the conduit. This could cause a piping failure in the embankment. Low areas noted in the bottom of the 36-inch conduit could be the result of pipe settlement caused by voids in the supporting soil. Recommendations are made in Section 7 for investigation of the conduits and future monitoring.

(2) The erosion on the slopes and at contacts with abutments have caused significant loss of embankment materials. The backfill for the outlet structure at the downstream end of the 36-inch diameter conduit has been eroded causing the crown of the 36-inch pipe to be exposed.

(3) The quick condition at the southerly downstream toe and the wetness of the downstream toes in general require investigation to determine a method of repair.

(4) The concrete headwall and endwall for the emergency spillway culverts are irregular in width and are cracked. The cracks appear to be a result of wall movements. The walls do not appear to have any foundation. Buttresses on the downstream wall do not have footings. Concrete work is rough and is honeycombed.

6.2 DESIGN AND CONSTRUCTION DATA

Seepage and slope stability analyses were made during design of the project. A failure arc tangent to the foundation line and having a 60-foot radius, was analyzed. Engineering checks of these computations were not made as part of this inspection report. A complete set of design and construction records are in the possession of James P. Olsen, P.E., the design engineer.

Various correspondence, legal documents, and inspection reports made by the State of Vermont are on file at the Vermont Water Resources Board in Montpelier.

6.3 POST-CONSTRUCTION CHANGES

At the time of this inspection report, the dam was judged to be about 85% complete.

6.4 SEISMIC STABILITY

The dam is located in Seismic Zone No. 2 and in accordance with recommended Phase I guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition

The Phase I visual inspection of Warren Lake Dam indicates that the dam is about 85% complete. The work remaining is considered to be necessary for the safe operation of the dam and as such, the dam is judged to be in poor condition and should not impound water. The dam has not impounded water to date, therefore deficiencies may not have been visible which might otherwise be detected if the dam was inspected under its full impoundment conditions.

b. Adequacy of Information

The adequacy of this dam was assessed based primarily on the visual inspection and sound engineering judgement. Available data including borings, test pits, design report, design plans, stability and seepage analyses, and specifications were reviewed. Information contained in the logs of soil borings at the south end of the dam (see Appendix B) was not sufficient to confirm if rock encountered in the borings was ledge or boulders.

c. Urgency

The recommendations and remedial measures described in Paragraphs 7.2 and 7.3 should be implemented by the owner within 12 months from receipt of this Phase 1 inspection report.

7.2 RECOMMENDATIONS

The owner should retain a qualified Registered Professional Engineer to:

(1) Make reassessment of the entire project from a design standpoint.

(2) Investigate and design repairs as necessary to insure the water tightness of joints in both the 36-inch and 24-inch diameter conduits. Instrumentation and a schedule for monitoring possible seepage along the conduits should be designed by a qualified geotechnical engineer. The low areas in the bottom of the 36-inch conduit should be investigated and repairs designed as necessary.

(3) Design methods to repair erosion gullies on the embankment slopes and at contacts with the abutments. A surface drainage system should be designed to prevent gullies from recurring. Also a permanent type vegetation type should be specified which will protect the embankment against erosion and not inhibit inspection of the slopes.

(4) Reevaluate the mechanical apparatus for the 24-inch drain conduit. The mechanisms should not be prone to plugging with debris or damage by ice.

(5) Investigate and design repairs to wet areas at the downstream toe including the 3-foot by 10-foot quick area at the southerly toe. As part of this investigation, the adequacy of the entire toe drain system should be evaluated to determine if improvements to or enlargement of the drainage system are necessary. Repairs to the deformed ends of the drain outlets should be designed including small animal guards at the downstream ends and caps on the cleanout risers.

(6) Establish methods and a schedule for monitoring flows from the toe drainage system.

(7) Investigate the hydraulic adequacy of the emergency spillway approach and discharge channels and design any necessary enlargements. Consideration should be given to potential damage to the dam caused by blasting of rock.

(8) Investigate the structural stability and design repairs or replacements to the cracked and irregular concrete headwall and endwall for the emergency spillway culverts. The deformations in the culvert walls should be investigated and repairs designed as necessary.

(9) Investigate and design repairs to the outlet structure for the 36-inch conduit including the eroded backfill and the rough concrete with embedded formwork. The outlet conditions at the 24-inch conduit should be investigated and methods designed to insure that discharge from the 24-inch conduit does not cause erosion of the outlet works for the 36-inch conduit.

(10) Investigate riprap on the upstream slope to insure that the adequate depth of riprap is provided and that the riprap is bedded with adequate filter material to prevent loss of embankment material from beneath.

(11) Supervise completion of the dam and record all as-built information and foundation conditions encountered during construction. A permanent bench mark and monumentation should be established to monitor future movements in the dam.

(12) Establish procedures and supervise filling of the lake when construction and all repairs are satisfactorily completed. Procedures during filling should include monitoring of flows from the toe drains and monitoring for possible seepage along conduits.

The owner should carry out all the recommendations made by the engineer. All work should be done under the engineer's supervision.

7.3 REMEDIAL MEASURES

The owner should implement the following remedial measures:

(1) Remove all dead and fallen trees and debris for at least 10 feet away from the main discharge channel and emergency discharge channel.

(2) Grade and establish vegetation within disposal areas downstream of the dam.

(3) Monitor seepage flows according to procedures and schedules specified by the engineer.

(4) Implement the existing formal written program for operation and maintenance.

(5) Engage a qualified Registered Professional Engineer to make a comprehensive technical inspection of the dam at least once a year.

(6) Develop a formal written program for warning downstream residents in case of an emergency (emergency preparedness program). The plan should include round-the-clock surveillance during periods of unusually heavy precipitation.

7.4 ALTERNATIVES

There are no practical alternatives to the above recommendations.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

DAM: WARREN LAKE DAM VT 263

DATE: 3 June 1981

TIME: 10:30 a.m.

WEATHER: Cloudy, dry

W.S. ELEV. 3" above invert in of 24" pond drain U.S.

2" below invert out of 24" pond drain DN.S.

ELEV. DATUM: NGVD based on design plans

INSPECTION PARTY:

1. J. F. Cysz, P.E. (Hydrology/Hydraulics)
2. K. N. Hendrickson, P.E. (Structural)
3. J. E. Walsh, P.E. (Baystate Environmental Consultants, Inc.) (Geotechnical)
4. R. E. Hoogs (Measurements)
5.
6.

OTHERS PRESENT DURING INSPECTION:

1. Lenord Robinson, Owner
2. J. P. Olsen, P.E., Design Engineer
3. A. Peter Barranco, P.E., Vermont Dept. of Water Resources
4.

VISUAL INSPECTION CHECKLIST

DAM: WARREN LAKE DAM VT 263 DATE: June 3, 1981

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	15"-18" below finish grade - rough graded only. Crest to carry 24' wide Plunkton Road.
Current Pool Elevation	3" above invert in of 24" Ø.
Maximum Impoundment to Date	None. Never been flooded.
Surface Cracks	None observed.
Pavement Condition	No pavement.
Movement or Settlement of Crest	Not applicable. Crest not yet to design grade - rough graded only.
Lateral Movement	Not applicable. Never flooded.
Vertical Alignment	Not applicable. Finish grading not yet complete.
Horizontal Alignment	Not applicable. Finish grading not yet complete.
Condition at Abutment and at Concrete Structures	Springs at left abutment causing localized quick condition in 3' x 10' area on left downstream toe (see sketch). Right abutment has 18" deep x 12" wide gully. Water now diverted, active seep 1/2 gpm at right abutment, 12" deep gully at left abutment/toe.
Indications of Movement of Structural Items on Slopes	Cleanout pipes on ends of foundation drain are tipped downstream - maybe by construction.
Trespassing on Slopes	Under construction.
Vegetation on Slopes	Sparse rye grass with hay mulch.

Note: Dam/lake never flooded.
Water control thru 24" Ø.

VISUAL INSPECTION CHECKLIST

DAM: WARREN LAKE DAM VT 263 DATE: June 3, 1981

AREA EVALUATED	CONDITION
DAM EMBANKMENT (continued)	
Sloughing or Erosion of Slopes or Abutments	No sloughing - random sheet and rill erosion (6" deep) both upstream and downstream slopes. Also gully is 18" deep at right abutment, 12" deep at left abutment and downstream toes. All headwalls washed out, gully 8"-12" around 48" riser.
Rock Slope Protection - Riprap Failures	Riprap not complete - thinly placed - 1 layer thick, 60% of length. No bedding, 6"- 10" size.
Unusual Movement or Cracking at or near Toes	None observed.
Unusual Embankment or Downstream Seepage	Springs at left abutment causing localized quick condition in 3' x 10' area on left downstream toe. 1/2 gpm seep on right abutment. Drip rust color in 36" Ø about mid length lower half of pipe joint. Entire left toe soft and wet by apparent springs.
Piping or Boils	Not applicable - pond empty.
Foundation Drainage Features	80' wide gravel blanket toe drain and 2' wide trench drains shown on plans.
Toe Drains	2 -6" PVC drains at each side of 24" outlet. Flow from south drain-1 quart/min. Flow from north drain-1 pint/min. Flow is clear, some rust slime at ends of 6" outlets. No animal guards on pipe ends. Ends of 6" drains deformed where they project through stone endwall. No caps on 6" PVC cleanout risers.
Instrumentation System	None.

VISUAL INSPECTION CHECKLIST

DAM: WARREN LAKE DAM VT 263 DATE: June 3, 1981

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Includes 48" principal spillway riser.
a. Approach Channel	Pond
Slope Conditions	No side slopes. Riser is in embankment.
Bottom Conditions	Not applicable.
Rock Slides or Falls	None.
Log Boom	None.
Debris	Pond not flooded.
Condition of Concrete Lining	Not applicable.
Drains or Weep Holes	Not applicable.
b. Intake Structure	
Condition of Concrete	Not applicable. 48" ACCMP riser.
Stop Logs and Slots	Not applicable. No stop logs.

Note: Construction not complete.

VISUAL INSPECTION CHECKLIST

DAM: WARREN LAKE DAM VT 263 DATE: June 3, 1981

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	48" ACCMP riser.
a. Concrete and Structural	
General Condition	Under construction.
Condition of Joints	Typical CM joints banded and tarred.
Spalling	Not applicable.
Visible Reinforcing	Not applicable.
Rusting or Staining of Concrete	No. Concrete in bottom of 48" up to 36" invert out.
Any Seepage or Efflorescence	Not applicable. Pond not flooded, dam under construction.
Joint Alignment	OK.
Unusual Seepage or Leaks in Gate Chamber	Not applicable.
Cracks	Not applicable.
Rusting or Corrosion of Steel	No. Asphalt coated pipe is new.
b. Mechanical and Electrical	No mechanical or electrical devices.
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	Note: Mud valve not yet installed on upstream end of 24" drain. Operating shaft not yet installed. Trickle flow and opening with sheargate not yet installed.
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

VISUAL INSPECTION CHECKLIST

DAM: WARREN LAKE DAM VT 263 DATE: June 3, 1981

AREA EVALUATED	CONDITION	
OUTLET WORKS - TRANSITION AND CONDUIT	36"	24"
General Condition of Concrete	ACCMP with banded and tar joints.	Observed interior from downstream end to upstream end. Horizontal and vertical alignment appears OK. Interior of 24" pipe is not visible. Can see upstream end from downstream.
Rust or Staining on Concrete	Not applicable.	Not applicable.
Spalling	Not applicable.	Not applicable.
Erosion or Cavitation	Not applicable.	Not applicable.
Cracking	Not applicable.	Not applicable.
Alignment of Monoliths	Not applicable. Three 1" deep sags 4' long in upstream 75' section of 36".	
Alignment of Joints	Lip of pipe deformed at joint - 40' upstream of outlet (approx.) drip in pipe joint about mid-length of 36" Ø, lower ½ of pipe joint. Max. flow to date 4" deep in 36" Ø.	
Numbering of Monoliths	Not applicable.	

VISUAL INSPECTION CHECKLIST

DAM: WARREN LAKE DAM VT 263 DATE: June 3, 1981

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Concrete headwall for 36" Ø. Rock headwall for 24" Ø, and discharge channel.
General Condition of Concrete	New work, rough construction.
Rust or Staining	No.
Spalling	No. Honeycomb, rough finish, some formwork not yet removed. Some wood embedded in concrete.
Erosion or Cavitation	Not applicable. No flow yet.
Visible Reinforcing	Form ties exposed. No rebars exposed.
Any Seepage or Efflorescence	No.
Condition at Joints	No joints observed.
Drain Holes	None.
Channel	
Loose Rock or Trees Overhanging Channel	No loose rock. Some trees on edge of discharge channel. (See photo.)
Condition of Discharge Channel	Fair.

Also note height of outlet relative to apron 2" actual, 2' plan.

VISUAL INSPECTION CHECKLIST

DAM: WARREN LAKE DAM VT 263 DATE: June 3, 1981

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNEL	Emergency spillway
a. Approach Channel	Under construction.
General Condition	Needs widening and realignment. Could become obstructed with debris.
Loose Rock Overhanging Channel	Yes.
Trees Overhanging Channel	No.
Floor of Approach Channel	Boulders and ledge.
b. Weir and Training Walls	Ledge walls on approach channel.
General Condition of Concrete	Weir is invert of 3 CMP arch culverts with rough, concrete headwalls. Headwalls have irregular thickness 5" - 8" thickness,vertical cracks above each culvert, improperly backfilled and washed out. Pipe arches deflected (2"-3"). One pipe arch rotated. No footings/cutoffs for headwalls observed. (See photos.)
Rust or Staining	No.
Spalling	Honeycomb.
Any Visible Reinforcing	No (form ties exposed).
Any Seepage or Efflorescence	No.
Drain Holes	No.
c. Discharge Channel	
General Condition	Not complete. No containment on right side.
Loose Rock Overhanging Channel	No loose rock - rock mass exposed on sides.
Trees Overhanging Channel	Yes. Cutting back required.
Floor of Channel	Natural and ledge cut.
Other Obstructions	Downed trees.

VISUAL INSPECTION CHECKLIST

DAM: WARREN LAKE DAM VT 263 DATE: June 3, 1981

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	No bridges. Earth fill over culverts to carry 2 lane 24' road, Plunkton Road. No service bridge to riser. Three culverts are 44" high by 72" wide (see Page A-8).
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Appraoch to Bridge	
Condition of Seat & Backwall	

APPENDIX B

ENGINEERING DATA

LIST OF AVAILABLE DESIGN,

CONSTRUCTION AND MAINTENANCE RECORDS

A. PLANS AND SPECIFICATIONS

Design Plans and Specifications dated August 1979 with revisions through August 1980 are on file with the Vermont Department of Water Resources in Montpelier and also from the design engineer, Mr. James P. Olson, P.E., RD 1 Box 163, Hinesburg, VT 05461. (Copies of selected plans are attached.)

B. DESIGN RECORDS

The design records are on file with James P. Olson, P.E.. A document entitled "Analysis and Design of a Private Recreational Pond for Jack C. Keir and Lenord Robinson, Warren, Vermont" Revised December 1979, is also on file with the Vermont Department of Water Resources. (Copy attached.)

C. CONSTRUCTION RECORDS

Construction records are on file with James P. Olson, P.E.. Periodic inspection reports by the designer and by the State Dam Safety Inspector are on file with the Vermont Department of Water Resources. No as-built plans or data were available at the time of the inspection.

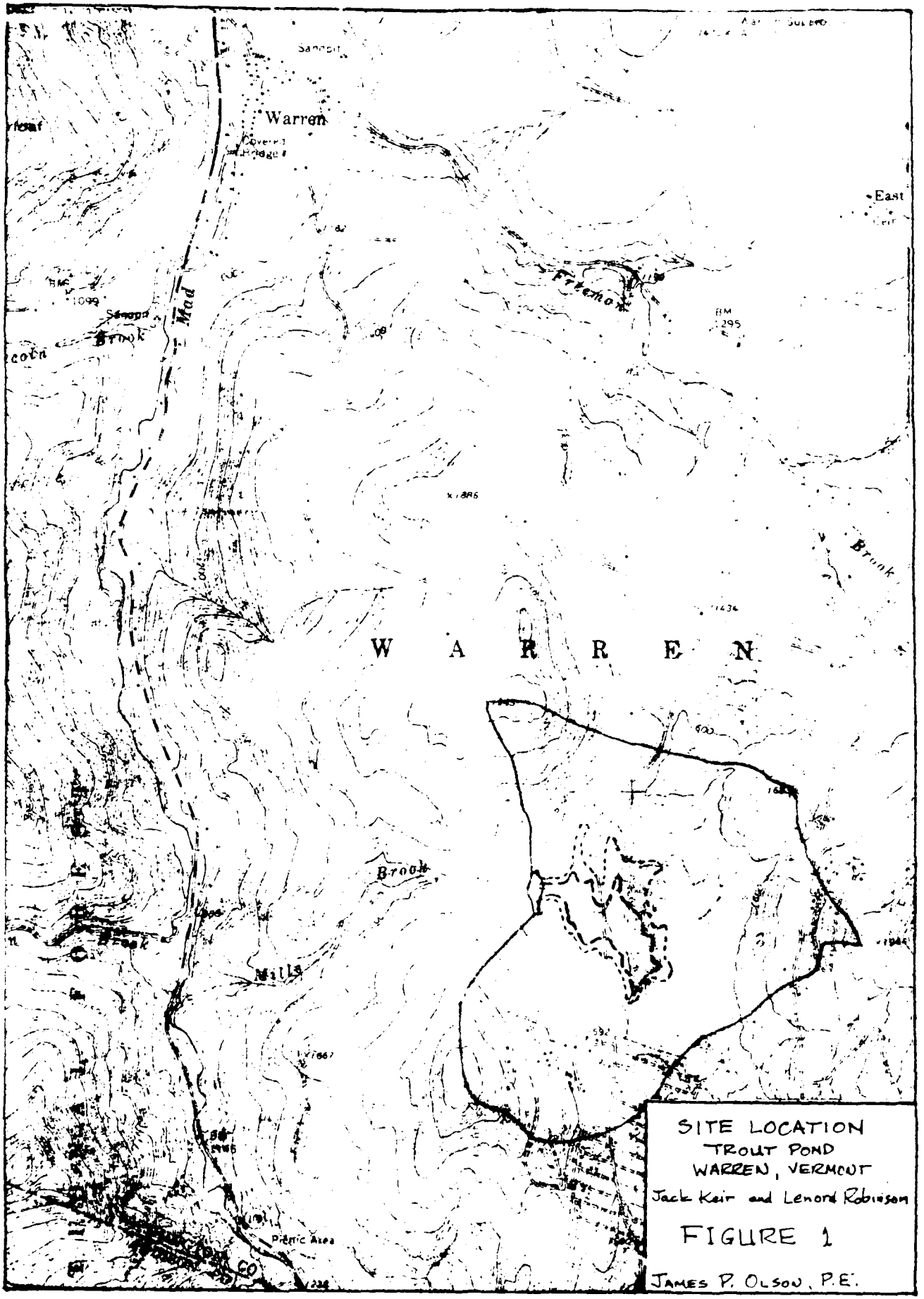
D. MAINTENANCE

No maintenance has been performed since construction is not complete. A maintenance plan has been drawn up. (Copy attached.)

Revised December 1973

ANALYSIS AND DESIGN
OF A
PRIVATE RECREATIONAL POND
FOR
JACK C. KEIR
AND
LENORD ROBINSON

WARREN, VERMONT


Warren
Covered Bridge
East
Mad
Brook
Freeman
WARREN
Brook
Mills
Brook
Picnic Area
SITE LOCATION
TROUT POND
WARREN, VERMONT
Jack Keir and Lenord Robinson
FIGURE 1
JAMES P. OLSON, P.E.

[illegible] A[illegible]

[illegible]ince th[illegible] project [illegible] by [illegible] small watershed in comparison with the surface area of the lake, normal run-off conditions [illegible] be handled by [illegible] (the [illegible]) [illegible] way. The emergency spillway will consist of a box culvert through the embankment and an earth excavated outlet section. The large [illegible] area of the lake ([illegible] acres) permits a large volume of water to be stored [illegible] periods. To evaluate the total flow quantities [illegible] during different storm events, three watershed discharge hydrographs were [illegible]. The method used to determine the hydrographs is outlined in [illegible] - [illegible], in Design of Small Dams, U. S. Bureau of Reclamation. [illegible] calculations for the hydrographs are [illegible] in the Appendix [illegible]. The three hydrographs plotted in [illegible] through 2[illegible] are [illegible] with [illegible]:

Figure [illegible]A - [illegible]
Figure 2B - [illegible] ([illegible])
Figure [illegible] - [illegible]

The second and third hydrographs [illegible] emergency spillway and freeboard hydrographs respectively [illegible] as defined in U.S.D.A. [illegible] Conservation Service [illegible] Release No. [illegible].

The results of the hydrograph [illegible] and the spillway discharge and stage conditions to be as follows:

Hydrograph	Lake Elevation	Emergency Spillway Stage
[illegible] year storm	[illegible]	[illegible] ft.
Emergency spillway	[illegible]	[illegible]
Freeboard	[illegible] ft.	[illegible] ft.

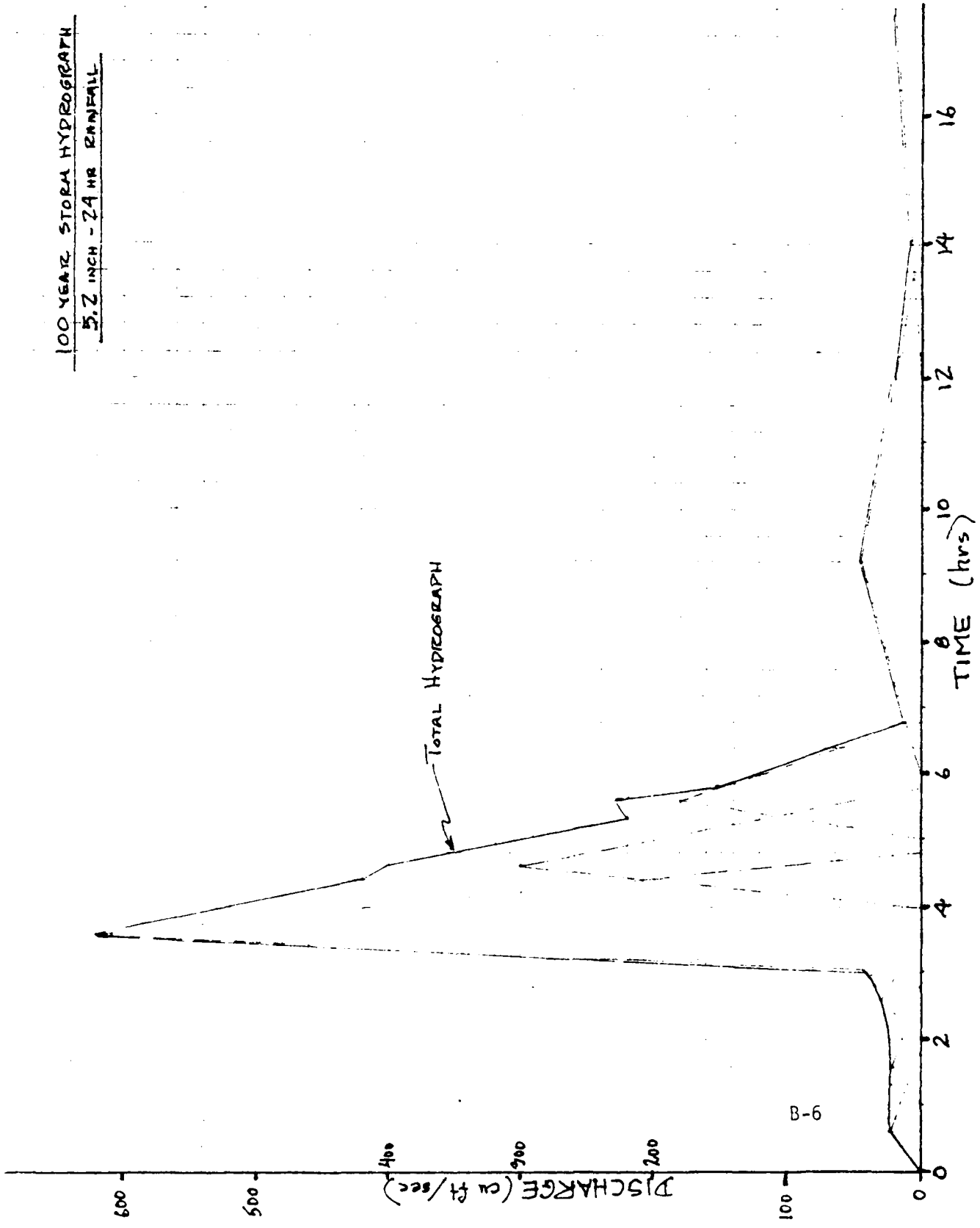
[illegible] are assumed [illegible] due to service spillway and emergency spillway discharge [illegible] flow in the [illegible]. [illegible] drawn from [illegible] that except [illegible] the emergency [illegible] little service [illegible] between [illegible].7 [illegible].

[illegible]

[illegible]

	Subject WATERSHED HYDROGRAPH	Made by JPO	Job No.
	WARREN LAKE	Checked by	Date DEC 1979
	100 YR. STORM	Approved by	Sheet No. FIG. 2A

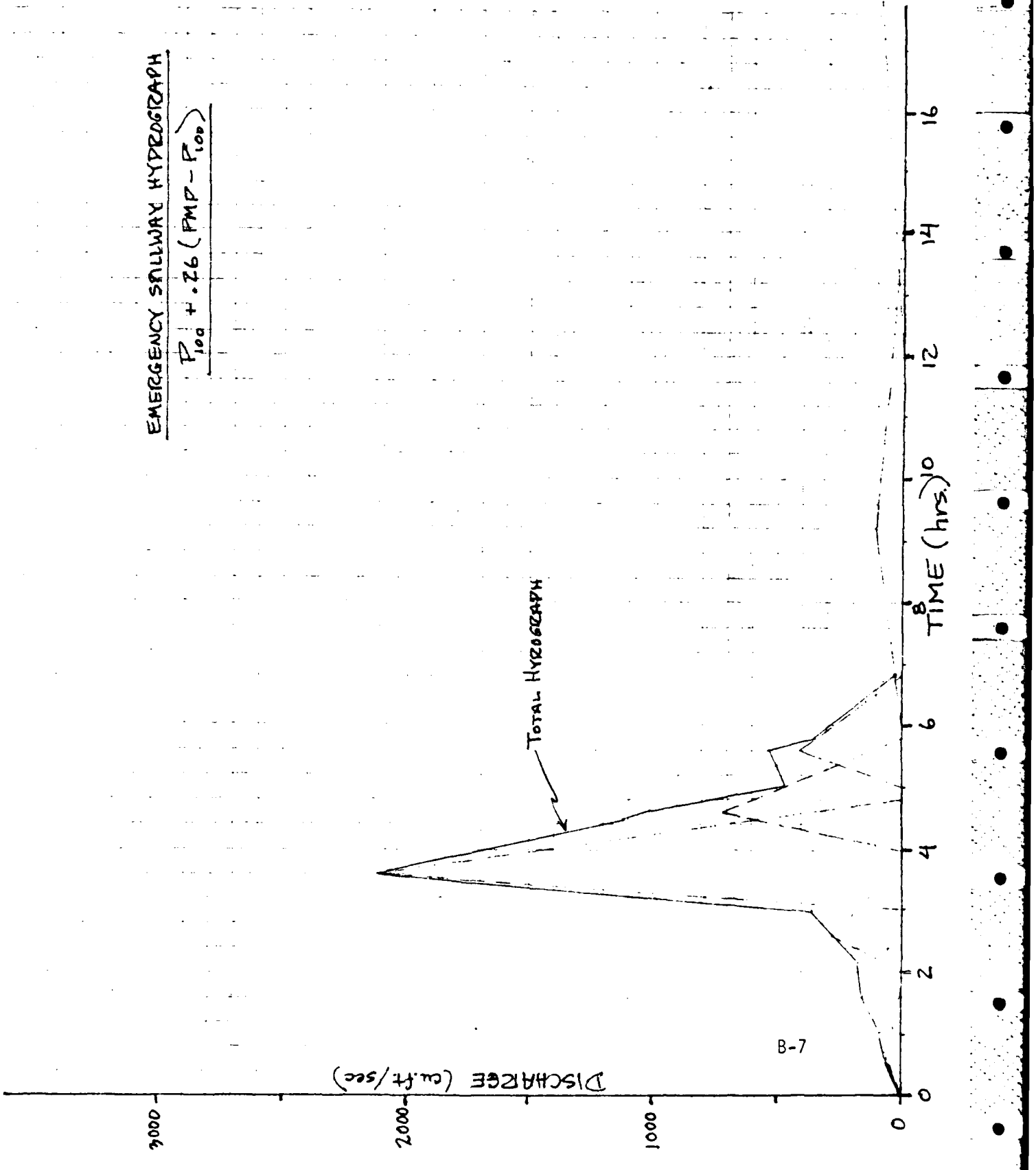
100 YEAR STORM HYDROGRAPH
5.2 INCH - 24 HR RAINFALL



	Subject	Made by	Job No.
	WATERSHED HYDROGRAPH	JPO	
	WARREN LAKE	Checked by	Date DEC 1979
	EMERGENCY SPILLWAY $P_{100} + .26(PMP - P_{100})$	Approved by	Sheet No. FIG. 2B

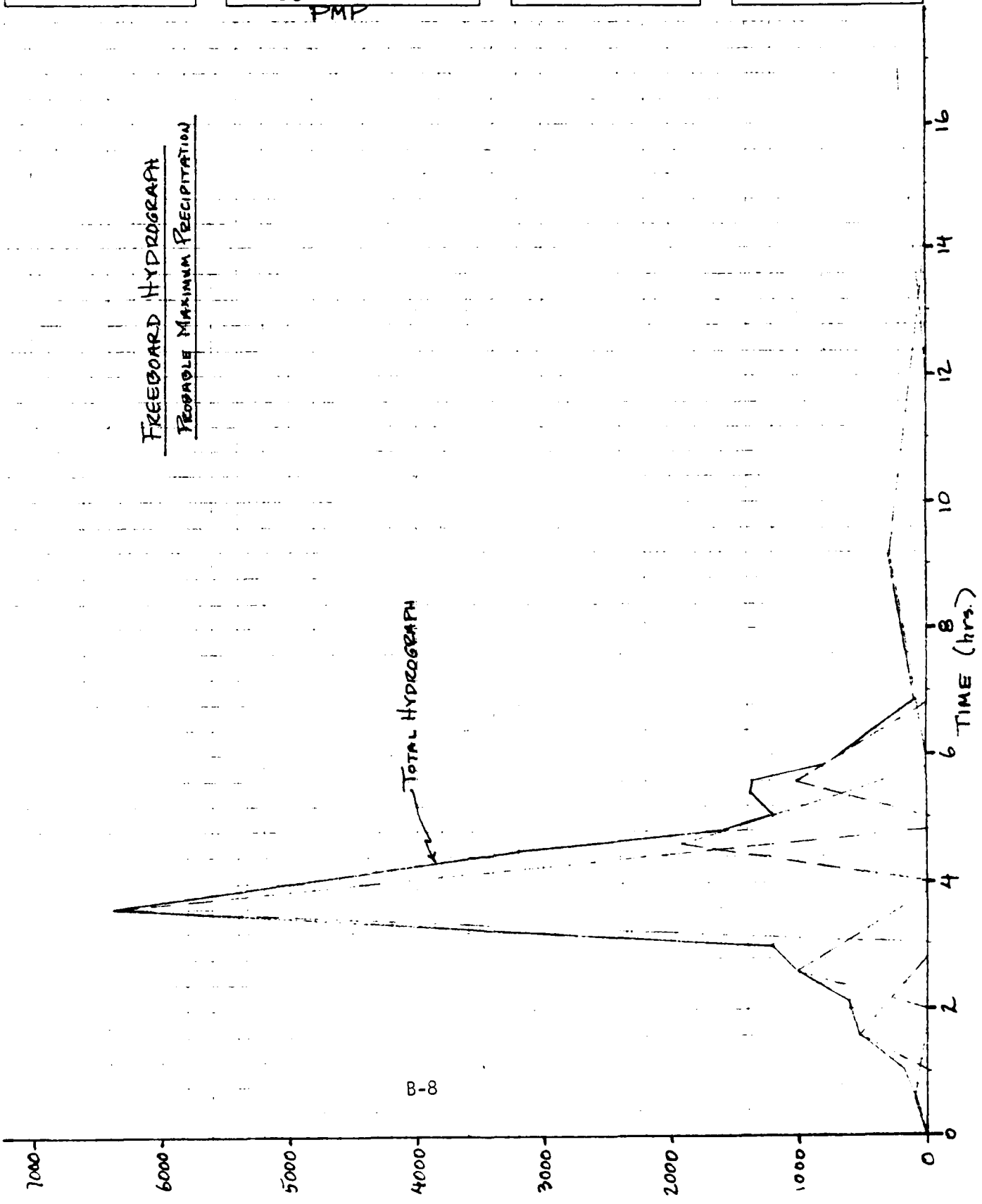
EMERGENCY SPILLWAY HYDROGRAPH

$P_{100} + .26\,(PMP - P_{100})$



	Subject WATERSHED HYDROGRAPH WARREN LAKE FREEBOARD CONDITION PMP	Made by JPO Checked by Approved by	Job No. Date DEC 1979 Sheet No. FIG. 2C

FREEBOARD HYDROGRAPH
PROBABLE MAXIMUM PRECIPITATION



COMPACTED EARTH EMBANKMENT (Continued)

Test pit logs and results of grain size analyses for soil samples considered representative of foundation conditions and borrow material are included in the Appendix. Further soil exploration and rock coring have taken place since the original report was prepared, and the soil types encountered were of the same type as previously sampled and reported. Bedrock depths vary from approximately 3 feet below existing ground to approximately 35 feet below existing ground. Typically, the shallow bedrock occurs on the south side of the stream and the deep bedrock is on the north side of the stream in the vicinity of the dam. The borehole locations and new test pit locations are shown on Drawing 1 - Topographic Plan and borehole logs are included in the Appendix.

Compaction test results for representative samples indicate that the soils to be used in the embankment have an optimum moisture content of approximately 10 percent and a maximum dry density of 127.2 pounds per cubic foot when compacted in a Standard Proctor laboratory compaction test. Based upon the laboratory results, 95 percent of the maximum dry density will be 120.8 pounds per cubic foot. The laboratory compaction data are presented in the Appendix.

HYDROGRAPH ANALYSIS

(PROCEDURE FROM U.S. BUREAU OF RECLAMATION)
(- DESIGN OF SMALL DAMS -)

1. TIME OF CONCENTRATION (Fig 13 Nomograph)

   $L = 3700$ ft. $\quad H = 400$ ft.

   $\therefore T_c = 0.20$ hours

2. TAKING THE 6 HR RAINFALL AS 83% OF 24 HR MAX.
   OR APPROXIMATELY 4.4 INCHES

3. HOURLY DISTRIBUTION OF 6HR. RAINFALL

Time (hr.)	% 6 hr. Value	Cummulative Rain	Incremental Rain
1	49	2.2	2.2
2	64	2.8	.6
3	75	3.3	.5
4	84	3.7	.4
5	92	4.1	.4
6	100	4.4	.3

4. HOURLY DISTRIBUTION OF 24 HR. STORM

TIME	INCR. RAIN	CUMM. RAIN
0-1	.3	.3
1-2	.4	.7
2-3	.5	1.2
3-4	2.2	3.4
4-5	.6	4.0
5-6	.4	4.4
6-12	.4	4.8
12-24	.4	5.2

5. HYDROGRAPH CONSTANTS

   a. 1-hr duration $\quad T_p = 0.6$ hrs. $\quad T_b = 1.6$ hrs.

   b. 6-hr duration $\quad T_p = 3.1$ hrs. $\quad T_b = 8.3$ hrs.

   c. 12-hr duration $\quad T_p = 6.1$ hrs. $\quad T_b = 16.3$ hrs.

Test Pit Logs (LOcations on Plan) July 19, 197?
Warren Lake - Warren, Vermont

TH-A1

0-1.5' Reddish-brown sandy loam
1.5-6' Grey silt, some stone, damp
6'-18' Greyish blue hardpan (Till), dry
No ledge encountered

TH-A2

0-1.0' Reddish-brown sandy loam
1.0-10' Grey silt, some stone, damp
Ledge (shale) encountered at 10' to 12' depth across test pit

TH-A3

0-1.0' Reddish-brown sandy loam
1.0-3.0' Grey silt, some stone, damp
Ledge (shale) encountered at 3' depth

TH-A4

0-1.0' Loam
1.0-10' Grey silt and stone, damp
Ledge encountered at 9' to 10' depth

TH-A5

0-1.0' Reddish-brown sandy loam
1-12.0' Grey silt and stone
12'-12.5' Gravel vein (pocket); not continuous
12.5'-18' Grey silt and stone, damp
No ledge encountered

TH-A6

0-1' Loam
1'-18' Grey silt, stone, till
No gravel encountered
No ledge encountered

COMPACTION TEST Data Sheet 9

Project [illegible] Job No. _____

Location of Project [illegible], Vt. Boring No. TP2 Sample No. 1 and 3

Description of Soil [illegible]

Test Performed By [illegible] Date of Test 23-24 Oct. 197[illegible]

Blows/Layer 25 No. of Layers 3 Wt. of Hammer 5.5 lb

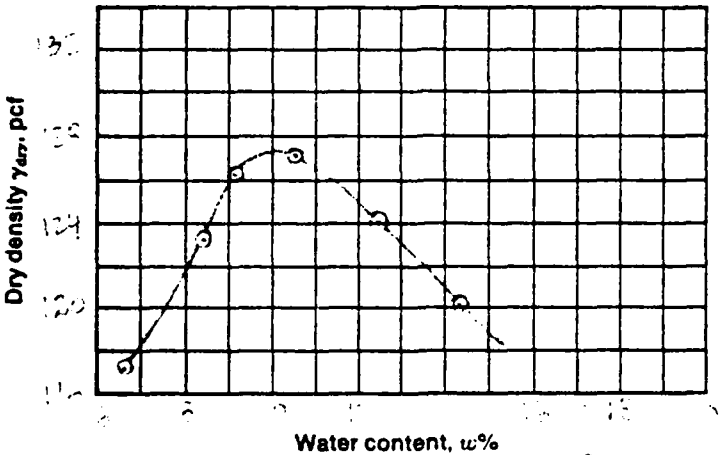
Mold dimensions: Diam. _____ ft Ht. _____ ft Vol. 1/30 cu ft

Water Content Determination

Sample no.	1		2		3		4		5		6	
Moisture can no.												
Wt. of can + wet soil	.31		[illegible]		[illegible]		[illegible]		[illegible]		.31	
Wt. of can + dry soil	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		.27	
Wt. of water	.04		[illegible]		[illegible]		11.33		[illegible]		.02	
Wt. of can	.15		[illegible]		[illegible]		[illegible]		[illegible]		.15	
Wt. of dry soil	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		.14	
Water content, w%	5.7		[illegible]		[illegible]		[illegible]		[illegible]		14.3	

Density Determination

Assumed water content	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14
Water content, w%	6.7	[illegible]	[illegible]	10.0	[illegible]	14.3
Wt. of soil + mold	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wt. of mold	4.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.66
Wt. of soil in mold	4.16	[illegible]	[illegible]	[illegible]	[illegible]	4.57
Wet density, pcf	[illegible]	[illegible]	[illegible]	140.4	[illegible]	137.1
Dry density γ, pcf	[illegible]	[illegible]	[illegible]	[illegible]	124.0	[illegible]



Optimum moisture = 10.0 % Maximum dry density = 127.2 pcf

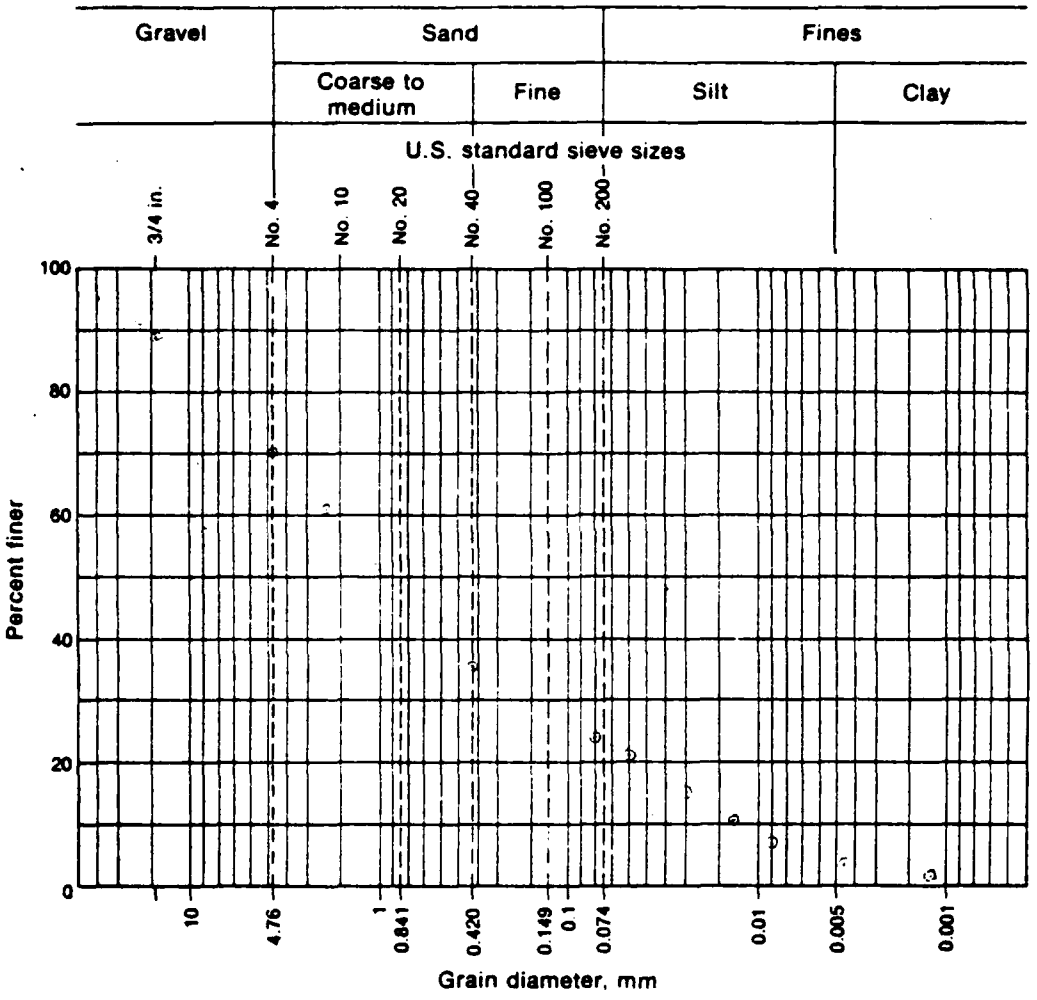
GRAIN SIZE DISTRIBUTION Data Sheet 5

Project _____ Job. No. _____

Location of Project _____ Boring No. _____ Sample No. 1

Description of Soil _____ Depth of Sample _____

Tested By. _____ Date of Testing _____



Visual soil description _____

Soil classification:

SM / SC System _____

D_{10} = .015 mm C_u = 133

D_{30} = .20 mm C_c = 1.16

D_{60} = 1.5 mm

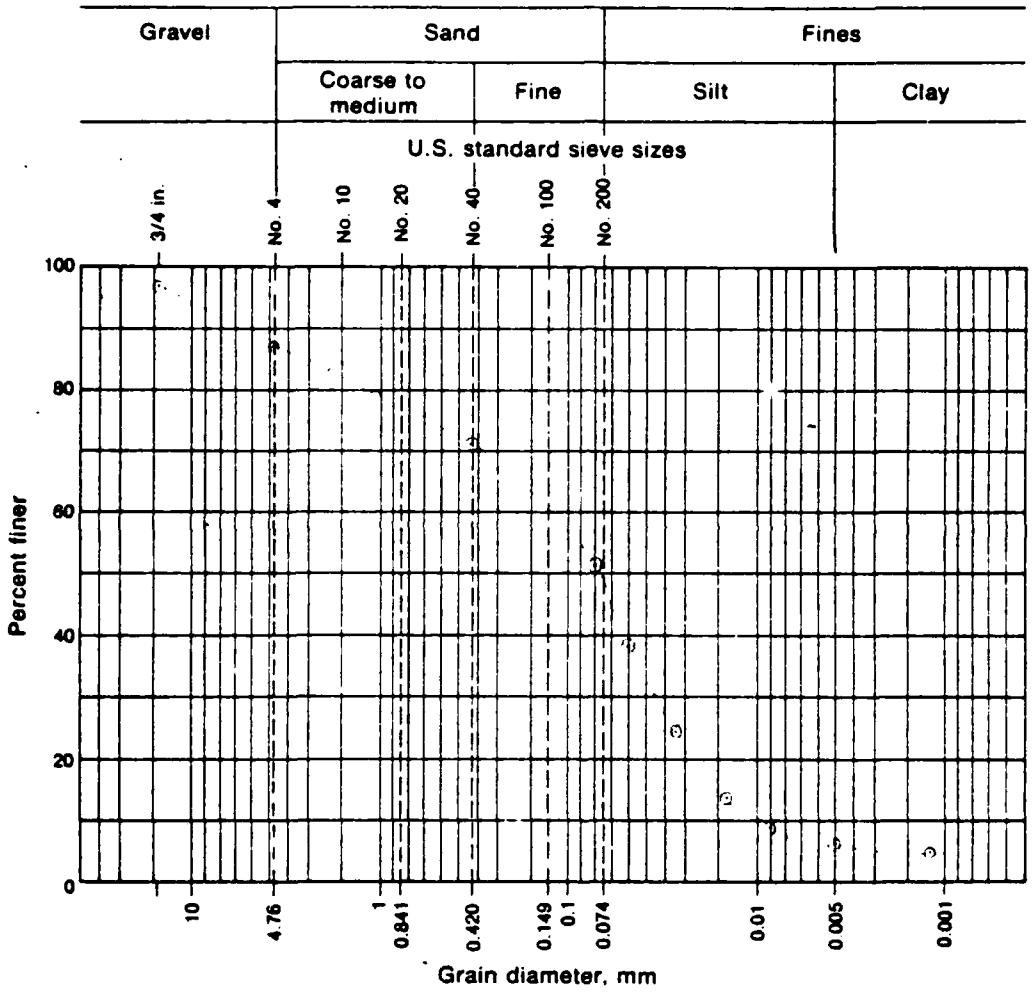
GRAIN SIZE DISTRIBUTION Data Sheet 5

Project _____ Job. No. _____

Location of Project _____ Boring No. _____ Sample No. 2

Description of Soil _____ Depth of Sample _____

Tested By. _____ Date of Testing _____



Visual soil description _____

Soil classification:

SM/SC _____ System _____

C_u = 15

D_{10} = .004

D_{30} = .05

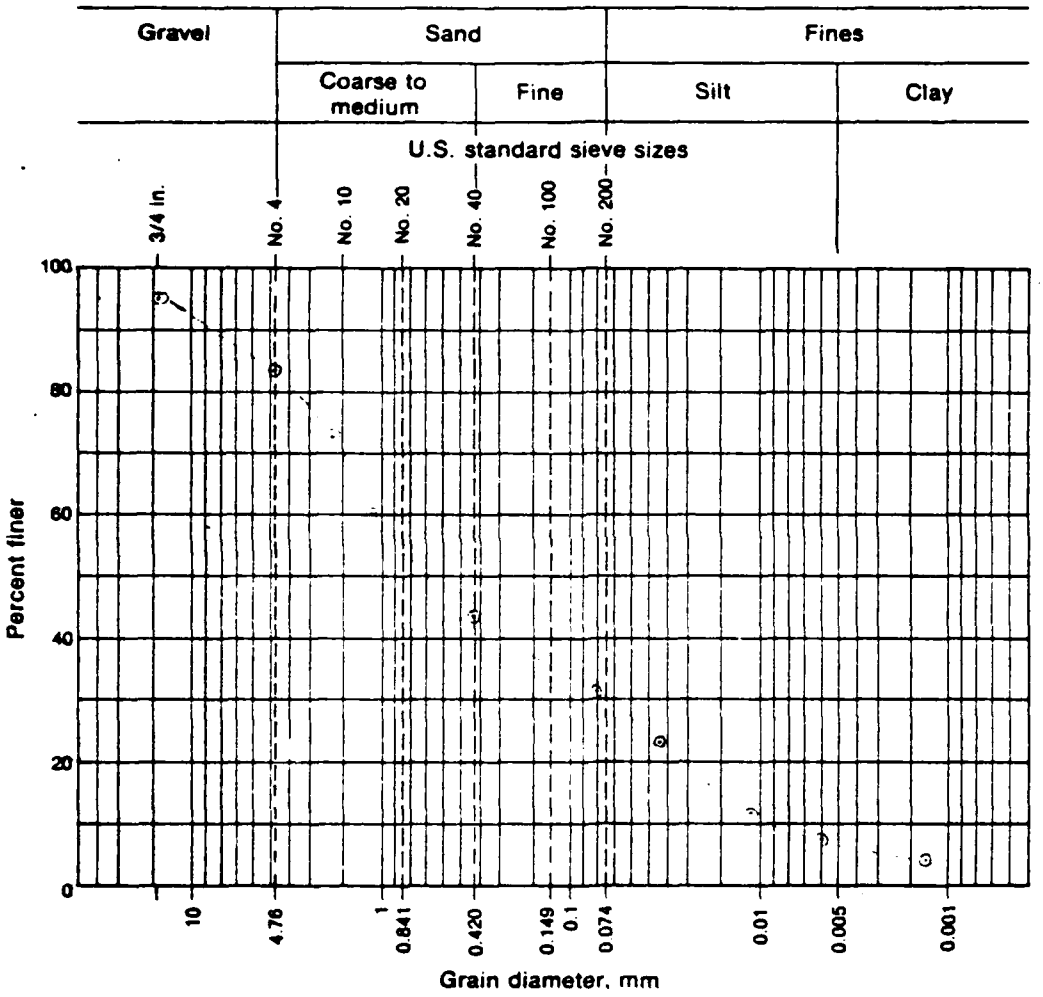
GRAIN SIZE DISTRIBUTION Data Sheet 5

Project _____ Job. No. _____

Location of Project _____ Boring No. _____ Sample No. 3

Description of Soil _____ Depth of Sample _____

Tested By. _____ Date of Testing _____



Visual soil description _____

Soil classification:

_____ System _____

marshfield
engineering
services

DONALD MARSH P.E.
MARSHFIELD, VERMONT 05658
802 426 3585

Lenord Robinson
Warren, Vermont

3 July 1979

Soils Investigations

TH-D-A			@ Station 23 + 10 R-20' (brook + 1.5' elevation)
	0	- 6"	Humus
	6"	- 1.5'	Black silty loam, silt
	1.5'	- 5'	Gray-green glacial till, moist but unsaturated, compact
	5'	- 7'	Brown fine silty sand
	7'	- 12'	Medium sandy gravel, saturated
			Some small clay-silt lenses
			Hole filled immediately with water @ 8'
			NLTD
TH-D-B			@ 28 + 84 L 100'
	0	- 6"	Humus
	6"	- 1.5'	Reddish-brown sandy loam
	1.5'	- 14'	Brown fine silty sand with lenses 4" to 12" thick of fine gravel from 11' to 14'
			NLTD NWTD
TH-13	0	- 6"	Topsoil
	6"	- 1'	Reddish-brown sandy loam
	1'	- 10'	Light gray silty sand with stones - till
			Not compact, not mottled
			Very compact @ 8'-10'
			NLTD NWTD
TH-14			@ S-24
	0	- 6"	Humus
	6"	- 1.5'	Reddish-brown sandy loam
	1.5'	- 9'	Light gray silty sand with stones - till
			Not compact, not mottled
			Slightly more compact @ 5'-6'
			NLTD NWTD
TH-15			@ S-22
	0	- 6"	Humus
	6"	- 1.5'	Reddish-brown sandy loam
	1.5'	- 9'	Light brown silty sand
			Not compact, not till
			NLTD NWTD

TH-16			@ S-20
	0	- 8'	Same soils as TH-15 but slightly more compact
			NLTD NWTD
TH-17			@ S-18
	0	- 8'	Same soils as TH-13
			Mottled from 2'-8'
			Seeps @ 6'
			Saturated gravel @ 6'-7'
			NLTD
TH-18			@ S-16
	0	- 6"	Topsoil
	6"	- 1'	Reddish-brown sandy loam
	1'	- 10'	Light gray-brown till, not compact
			Mottled from 4'
			Seeps @ 8'
			NLTD
TH-19	0	- 8'	Same soils as TH-13
			Not mottled, not compact
			NLTD NWTD
TH-20	0	- 6"	Humus
	6"	- 2'	Reddish-brown sandy loam
	2'	- 4'	Light gray-brown silty sand (till), more compact, not mottled
	4'	- 5'	Medium sandy gravel
	5'	- 8'	Till with many stones
			NLTD NWTD
TH-21	0	- 6"	Humus
	6"	- 7'	Light gray-brown till, mottled from 3'-4'
			More compact @ 4'
	7'		Ledge or boulder
			NWTD
TH-22	0	- 6"	Topsoil
	6"	- 2'	Reddish-brown sandy loam
	2'	- 7'	Gray-brown till, not too compact, not mottled
			NLTD NWTD

NLTD - No ledge to depth
NWTD - No water to depth

Donald Marsh, P.E.

[illegible]

WARREN LAKE - MAINTENANCE PROCEDURE

Maintenance and operation of the dam constructed for impoundment of Warren Lake will be performed on a regular schedule to insure the normal operation of equipment and appurtenances and allow for efficient functioning of service and emergency spillways and drains. Specific items to be checked and operated, and their schedules are listed:

1. The gate valve for the emergency pond drain will be fully opened and closed at least once each year. The Department of Water Resources will be notified prior to operation so that a representative may be present to monitor any release of sediments. Measures may be required to control the release of any accumulated sediments.
2. Vegetation in the emergency spillway approach and outlet sections will be mowed at least twice each growing season. Vegetation on both upstream and downstream slopes of the embankment will be mowed at least annually. Brush and tree growth will not be permitted within the emergency spillway approach and exit channel, nor on the embankment slopes, nor within 10 feet of the toe of the downstream slope.
3. Snow removal will take place as necessary to provide free water flow through the emergency spillway at all times.
4. The pond level control valve will be operated at least once each year to insure normal operation.
5. The trickle tube flow aperature will be inspected monthly during the summer months to insure maintenance of minimum flow conditions.
6. All conduits will be visually inspected twice each year. If debris has accumulated in a conduit, it will be cleaned to allow unobstructed flow of water. If deterioration is observed, the Vermont Department of Water Resources will be informed immediately to allow their inspection and evaluation.
7. The emergency spillway and service spillway, pond drain, and foundation drain and appurtenances will be kept clear of debris and in good operating order at all times.

8. The "plunge pool" at the exit point of the service spillway conduit will be inspected each Spring and Fall to insure that excess erosion is not occurring. If erosion is deemed excessive, remedial measures will be taken as soon as possible after consultation with the Department of Water Resources.

9. The crest, upstream slope and downstream slope, and toe of the embankment will be inspected at least annually. Any serious problem such as cracking, slumping, piping, or seepage will be immediately reported to the Department of Water Resources.

10. If routine inspection by the Water Resources Department reveals the existence of any maintenance problems, such measures to correct the problem will be undertaken in accordance with their directive.

PREVIOUS INSPECTION REPORTS

Construction Progress Reports were prepared by the design engineer twice a month during 1980 construction and submitted to the Vermont Department of Water Resources. The State Dam Safety Inspector also made periodic visits to the site during construction. These reports are on file with the Vermont Department of Water Resources. Copies of selected reports are attached.

ADM 9/15/80

September 12, 1980

Water Resources Department
Water Resouces Board
c/o Mr. A Peter Barranco
Agency of Environmental Conservation
Montpelier, VT 05602

Subject: Construction Progress Report-Robinson/Keir Dam, Warren, Vermont

Dear Mr. Barranco:

This letter is a Construction Progress Report for the subject project. At present the placement and compaction of the embankment is the major activity taking place at the site. Progress since the last reporting period is detailed as follows:

1. Compacted fill for the embankment has risen to elevation 1554+ (as of Sept. 8, 1980). Field compaction tests were taken with a Nuclear moisture-density gage as filling and compaction has proceeded. Test data at elevations 1542 to 1545 and 1553 to 1554 indicate consistent densities averaging 97.5 percent compaction. Moisture content of the fill at placement has ranged from 5% to 16.5% with an average of 9.3%.

2. One week of time was lost while efforts were under way to resolve a difference of opinion over the quality of material(gravel) to be used in constructing the downstream toe drain. The installation of the drain has now been completed to the satisfaction of the Dept. of Water Resources.

3. Work is presently underway on the construction of the foundation for the 48 inch riser pipe and placement of the riser for the service spillway.

It is our estimate that the remainder of the embankment will be completed to approximately subgrade elevation (1564) by the end of the next reporting period. At that time, we would anticipate seeding with a rye grass and mulching to attempt to catch some growth before wintering over.

At this time, comparing the work completed and in progress with the schedule submitted, all major items are on schedule or ahead of schedule except for two items. One is the emergency spillway and the other is the relocated roadway. We have delayed working on the spillway since we were studying the feasibility of requesting a modification to the spillway and have subsequently done so. The roadway work away from the embankment is work that can be completed during the Fall and Winter months prior to closing the drain in the Spring of 1981.

We hope this report has addressed each of the issues desired by the Board in condition 8 of the permit. We anticipate a request for an extension of the construction period will be made at the upcoming Board meeting on Sept. 22, 1980.

This request will deal with time necessary for completing the installation of the emergency spillway and the request to allow work on the roadway to continue into the winter. It is estimated that all work associated with the embankment will be completed by October 31, 1980 if the spillway modification is approved. If the modification is not accepted, then the spillway construction will be expected to be completed by November 15, 1980.

Sincerely yours,

James P. Olson

James P. Olson, P.E.

11/12/80

RD 1
Hinesburg, Vermont 05461

November 6, 1980

Water Resources Department
Water Resources Board
c/o Mr. A. Peter Barranco
Agency of Environmental Conservation
Montpelier, Vermont 05602

Subject: Robinson/Keir Dam - Warren, Vermont

Dear Mr. Barranco:

This letter is a Construction Progress Report for the Robinson/Keir Dam for the period October 16, 1980 to November 3, 1980. The progress to date is as follows:

1. Seeding and mulching of the embankment slopes has been completed with the exception of a small area at the south end of the embankment adjacent to the emergency spillway conduits.

2. Concrete headwalls and buttresses (or counterforts) are in place for the emergency spillway conduits.

3. With items 1 and 2 above complete, the sturcture of the embankment is in place and complete except for placement of the gravel roadbed surface. The Contractor has been precluded from completing the gravel fill due to rainfall occurring on a sufficient number of days to keep the surface wet and unworkable.

4. Corollary items which now remain to complete the overall project are:

    a. completion of gravel road south of the embankment connecting to the original road,

    b. placement of the trash rack/anti-vortex plate to the service spillway inlet,

    c. installation of the pond drain valve and level control valve.

The undersigned and the Contractor will await word from you and/or the Board to schedule a site visit and inspection as you deem necessary. Also, if there are questions pertaining to this submittal, please call at your convenience.

Sincerely yours,

James P. Olson

James P. Olson, P.E.

JPO/jcd
cc: L. Robinson
J. Keir
J. Hutton
W. Bartlett

VERMONT DEPARTMENT OF WATER RESOURCES

By Dam Safety Engineer

Inspection Report No. 5

dated August 16, 1980

8-17-80

1/2

To: File

Fm: AJB

Subj: Warren Lake Dam – Inspection #5

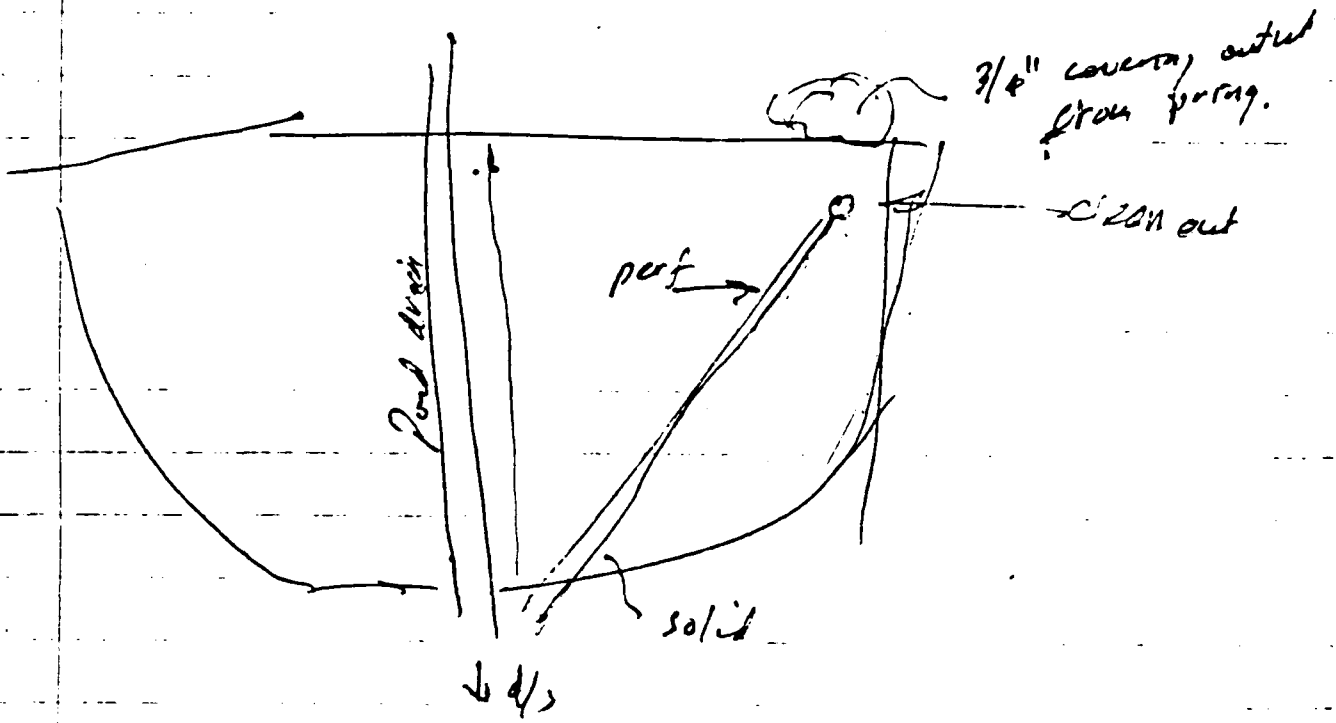
On Saturday 8-16-80 @ 1015 – 1045 the writer inspected the site. A clean river gravel was being placed in the section of the blanket drain left of the pond drain. The material was being spread by a small bulldozer and being placed by hand around the collector/discharge pipe. The u/s end of the pipe has ~~stell~~ perforation and lower section is solid. (Note: This is a straight section of pipe and combines both collector and discharge pipe in one section. No filter fabric was around the perforated pipe as proposed by Jim Olson on 8/13/80).

The 3/4" screened gravel had been substantially removed, however, some was left at the u/s left corner of the drain, where, according to Leonard Robinson it covered some pipes leading from a spring encountered in that area. Although this is acceptable, it was pointed out to the contractor's men that it was very important that this pocket of 3/4" gravel be completely isolated by the approved drain fill and that no contraction seams or layers of the 3/4" be permitted to remain that would connect any part of the embankment to the d/s toe or to one of the collector pipes.

B-25

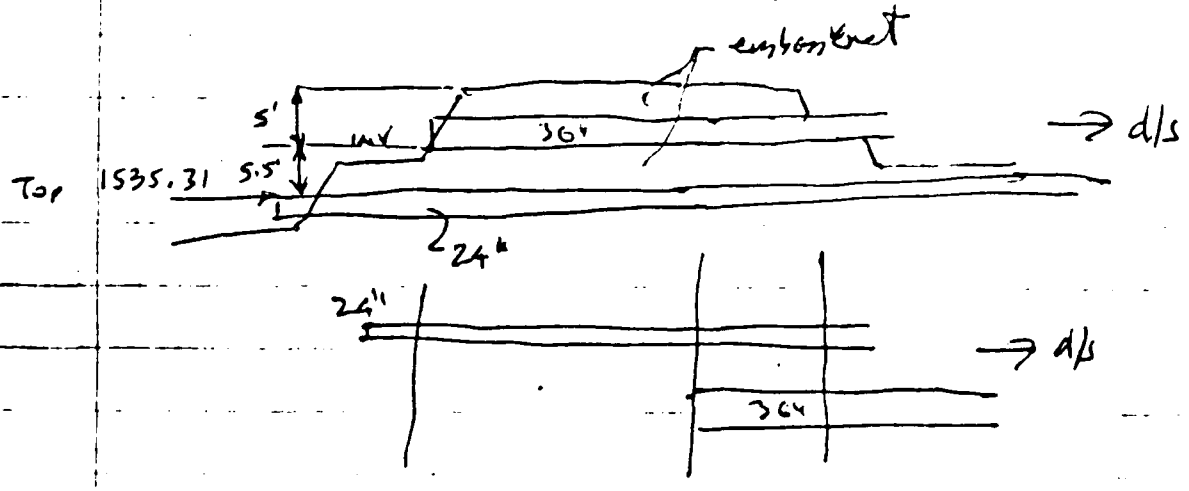
Because of the possibility of some of the 3/4"

material not being removed properly and the as built configuration of the collector pipes, this dam will have to be monitored very closely during and after filling.



Photos Taken

The 36" barrel has been partially installed.



State of Vermont

8/11/80

AGENCY OF ENVIRONMENTAL CONSERVATION

Department of Fish and Game
Department of Forests, Parks, and Recreation
Department of Water Resources and Environmental Engineering
Division of Protection
Natural Resources Conservation Council

Montpelier, Vermont 05602
Department of Water Resources
and
Environmental Engineering

WATER QUALITY DIVISION

August 11, 1980

Mr. John G. Hutton, Esq.
Bridge Street
Waitsfield, VT 05673

RE: Warren Lake Dam - Warren

Dear Mr. Hutton:

This is to confirm our telephone conversation on August 8, 1980 regarding the blanket drain at the Warren Lake Dam and the Department's position that the drain as presently installed is unacceptable and should be removed and replaced with gravel and/or sand meeting specifications.

As requested, I am herewith enclosing copies of my letters of July 30, 1980 and August 4, 1980 to Jim Olson concerning the blanket drain.

Please be assured that I am anxious that this project go forward with as little delay as possible so that your clients achieve a safe and successful project at an early date.

Sincerely,

A. Peter Barranco, Jr. P.E.
Dam Safety Engineer

APB/las

Enclosure: Letters

cc: James P. Olson, P.E.
Lenord Robinson
William Bartlettt

State of Vermont

AGENCY OF ENVIRONMENTAL CONSERVATION

Department of Fish and Game
Department of Forests, Parks, and Recreation
Department of Water Resources and Environmental Engineering
Division of Protection
Natural Resources Conservation Council

Montpelier, Vermont 05602
Department of Water Resources
and
Environmental Engineering

WATER QUALITY DIVISIO

ROUTING

GENERAL		
TO	NOTED	DATE
HB		7/30/80
RETURNED TO		
FILE		

July 30, 1980

Mr. James P. Olson, P.E.
RD #1
Box #163
Hinesburg, VT. 05461

RE: Warren Lake Dam - Warren

Dear Jim:

This is to confirm our telephone conversations on July 28 and 30 regarding the blanket drain and the gravel samples I took when I inspected the site on July 25.

Two samples were taken and analyzed by the Agency of Transportation's Materials Division. Sample #1 was taken from a pile of surplus gravel near the right clean-out and Sample #2 was taken from the in-place drainage blanket to the left of the pond drain. Care was taken to insure that these were representative samples. Fine content (percent passing No.200 sieve) was as follows:

Sample #1 - 10% (total sample) 19% (sand portion)
Sample #2 - 7% (total sample) 9% (sand portion)

If these samples are representative of the material in the drainage blanket they are well in excess of the maximum 2% called for in the specifications and are unacceptable. The entire drainage blanket should be removed and replaced with material meeting the specifications.

In addition, it was noted during the inspection that the 6" drain discharge pipes leading from the collector pipe were perforated. These should be replaced with solid pipe as called for in the plans.

James P. Olson, P.E., July 30, 1980

Please let me know when the blanket drain and pipes have been replaced so that I can inspect it before it is covered again. I would also like you to provide me with a copy of a sieve analysis for the new drainage material.

Sincerely,

A. Peter Barranco, Jr., P.E.
Dam Safety Engineer

APB/las

State of Vermont

AGENCY OF ENVIRONMENTAL CONSERVATION

Department of Fish and Game
Department of Forests, Parks, and Recreation
Department of Water Resources and Environmental Engineering
Division of Protection
Natural Resources Conservation Council

ROUTING	
GENERAL	
TO	NOTED DATE
	GMB 8/5/80
August 4, 1980	
SUSPEND TO	
FILE	

Montpelier, Vermont 05602
Department of Water Resources
and
Environmental Engineering
WATER QUALITY DIVISION

Mr. James P. Olson, P.E.
RD #1, Box #163
Hinesburg, VT 05461

RE: Warren Lake Dam - Warren

Dear Jim:

This will confirm your telephone call at 8:00 a.m. Monday, August 4 advising me that the blanket drain had been removed and replaced with screened gravel (3/4" - 1") and that the toe drain discharge pipes had been replaced with solid pipe. It is my understanding that this work was at least substantially completed last Saturday (August 2). Prior commitments did not permit me to inspect the site on August 4.

As stated in my letter of July 30, the original gravel material in the drain was unacceptable and should be replaced with material meeting the specifications, and the perforated pipe should be replaced with solid pipe as called for in the plans. I also indicated in my letter that I wanted to inspect the installation before it was covered.

Although I am pleased that the unsuitable material and pipes were replaced, I am quite disturbed that the replacement material was not a graded gravel meeting the specification but, as I understand it a nearly uniform screened gravel (3/4" - 1"). This material obviously meets permeability requirements but does not meet piping criteria, and resistance to piping must be accomplished solely by the filter fabric. If the filter fabric meets filter requirements and is installed properly the system theoretically should perform well. However, it is critical that the fabric is installed so that no gaps or tears are present or can develop in which case piping could be readily initiated.

Although the drain could perform well, it is still a potentially dangerous system for a homogeneous earth dam with silty soils. Since this is a Class 1 dam, I do not feel that reliance on the filter fabric as the sole means of preventing piping is a wise decision and in my opinion the drain in unacceptable and should again be replaced with material meeting the specifications.

Sincerely,

A. Peter Barranco, Jr. P.E.

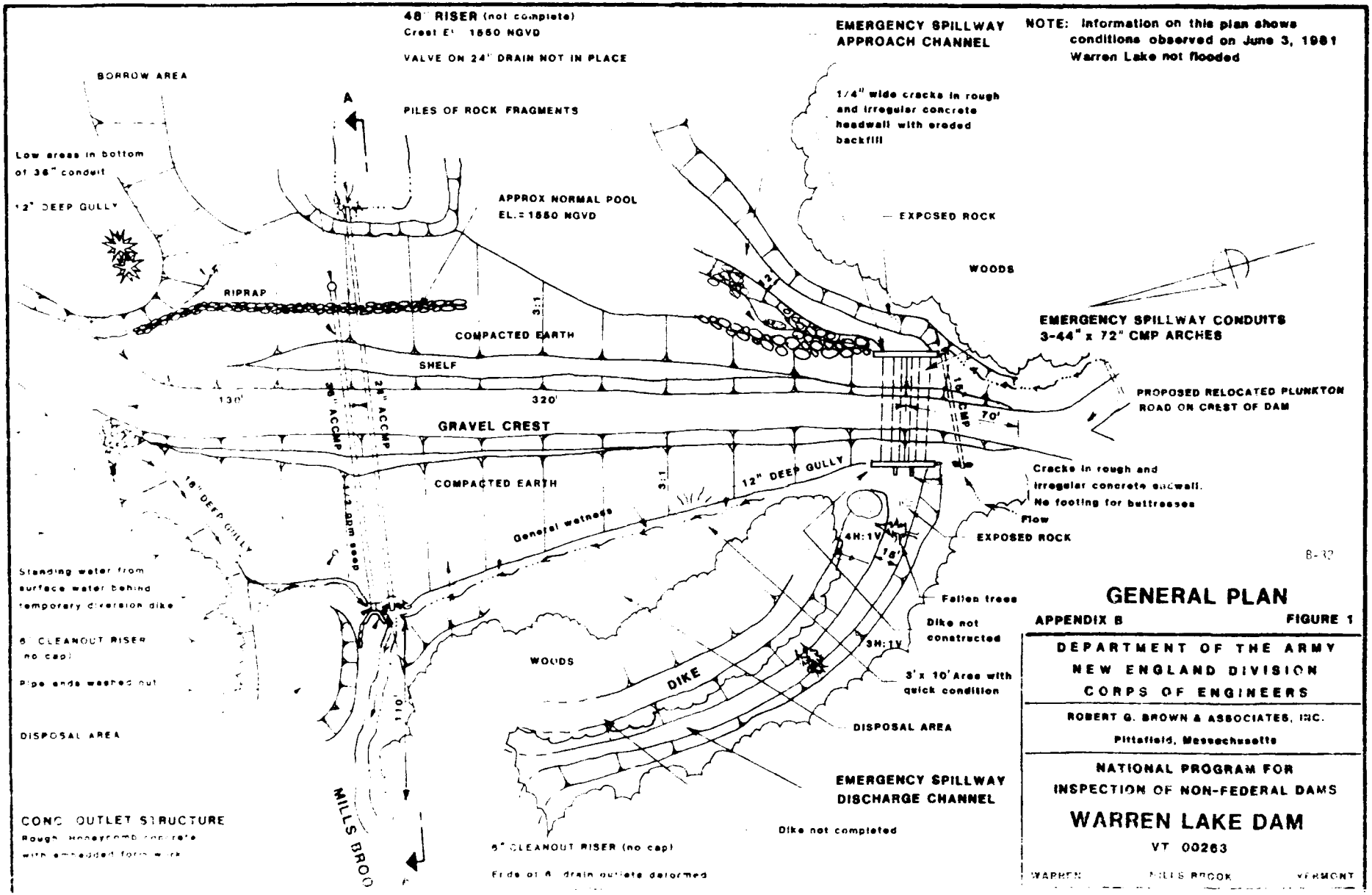
A. SKETCHES COMPILED DURING PHASE I INSPECTION SHOWING GENERAL LAYOUT OF DAM, TYPICAL SECTIONS AND DETAILS OF SIGNIFICANT FEATURES:

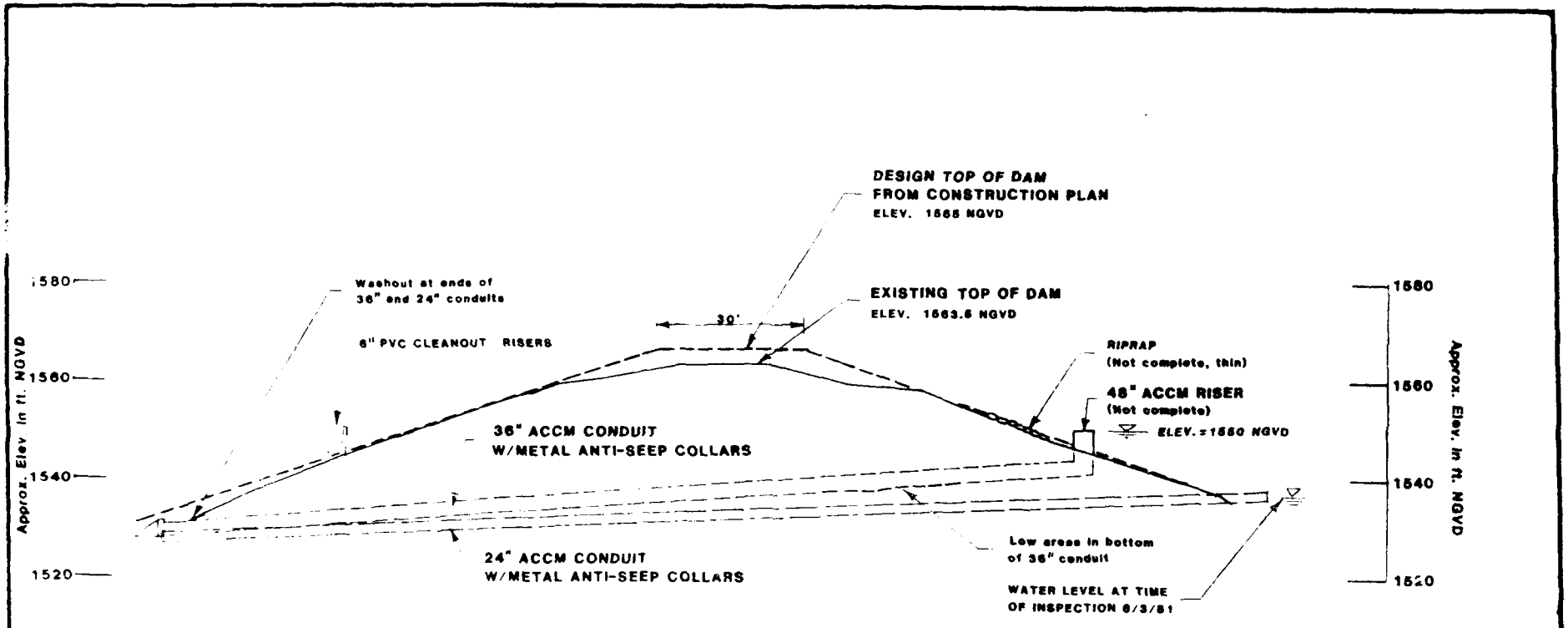
Figure 1. General Plan of Damsite

Figure 2. Typical Section

B. CONSTRUCTION PLANS:

Sheet 3R Alt #2:	Proposed Revision Emergency Spillway
Sheet 4:	Sections and Details - I
Sheet 4A:	Sections and Details - II
Sheet 4A Revision:	Pond Drain Valve
--	Mud Valve details

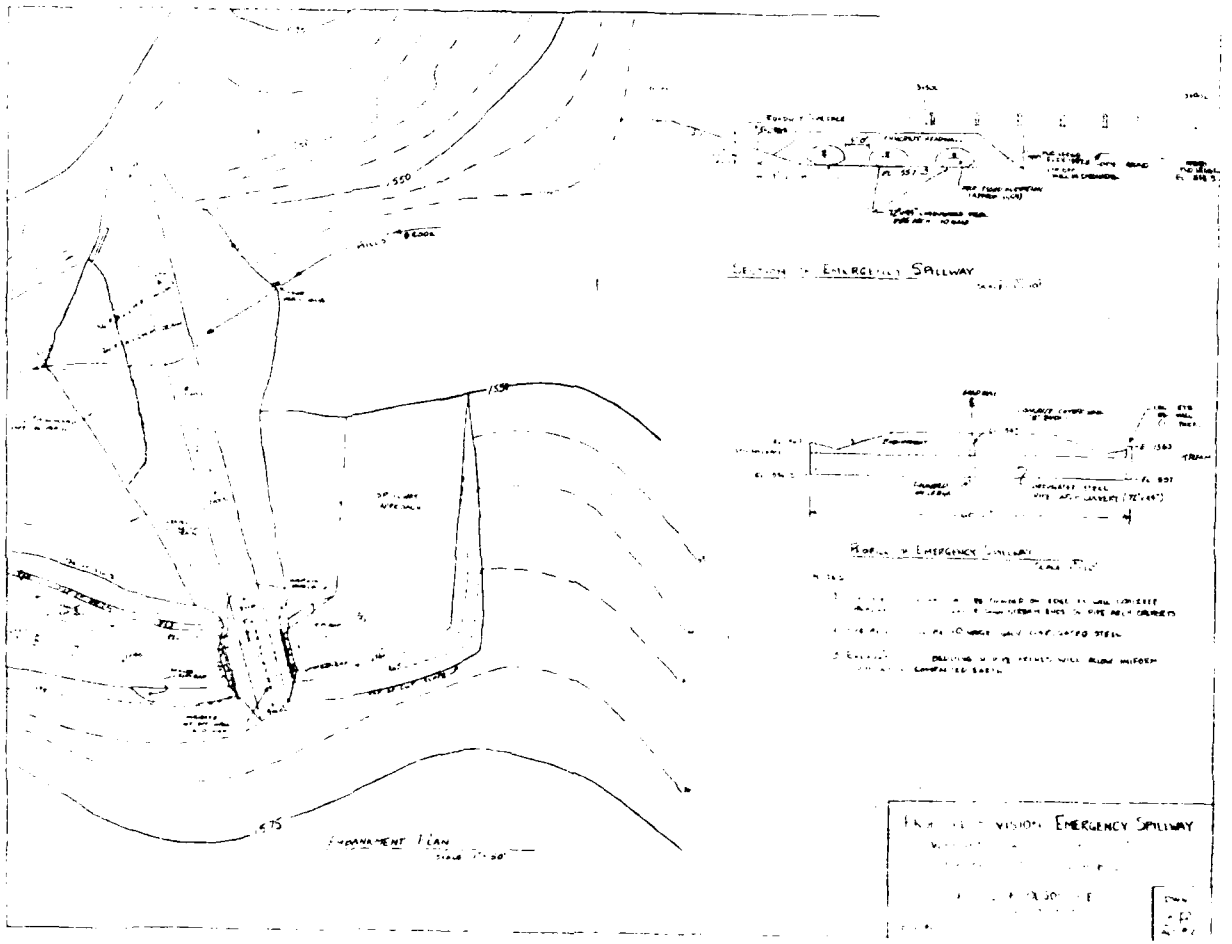

48" RISER (not complete)
Crest El. 1650 NGVD
VALVE ON 24" DRAIN NOT IN PLACE
EMERGENCY SPILLWAY APPROACH CHANNEL
NOTE: Information on this plan shows conditions observed on June 3, 1981 Warren Lake not flooded
BORROW AREA
PILES OF ROCK FRAGMENTS
1/4" wide cracks in rough and irregular concrete headwall with eroded backfill
Low areas in bottom of 36" conduit
12" DEEP GULLY
APPROX NORMAL POOL EL.= 1650 NGVD
EXPOSED ROCK
WOODS
RIPRAP
COMPACTED EARTH
SHELF
EMERGENCY SPILLWAY CONDUITS 3-44" x 72" CMP ARCHES
130'
320'
PROPOSED RELOCATED PLUNKTON ROAD ON CREST OF DAM
GRAVEL CREST
Cracks in rough and irregular concrete endwall. No footing for buttresses
Flow
EXPOSED ROCK
General wetness
4H:1V
Standing water from surface water behind temporary diversion dike
6" CLEANOUT RISER no cap
Pipe ends washed out
Fallen trees
Dike not constructed
3H:1V
WOODS
DIKE
3' x 10' Area with quick condition
DISPOSAL AREA
EMERGENCY SPILLWAY DISCHARGE CHANNEL
CONC OUTLET STRUCTURE
Rough honeycomb concrete with embedded form wire
6" CLEANOUT RISER (no cap)
Dike not completed
Ends of 6" drain outlets deformed
MILLS BROOK
B-32
GENERAL PLAN
APPENDIX B
FIGURE 1
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
ROBERT G. BROWN & ASSOCIATES, INC.
Pittsfield, Massachusetts
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
WARREN LAKE DAM
VT 00263
WARREN
MILLS BROOK
VERMONT

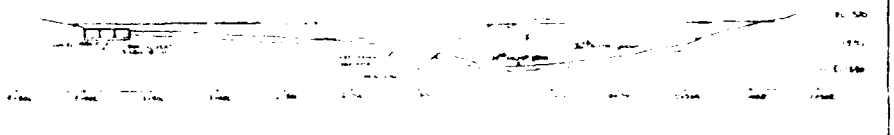


SECTION A-A

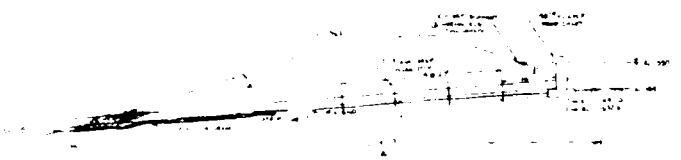
NOT TO SCALE

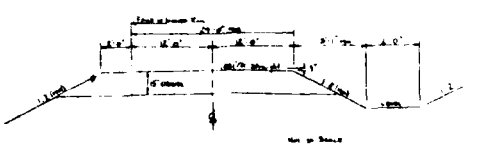
APPENDIX B FIGURE 2



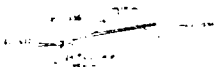


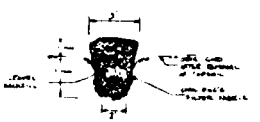
EMBANKMENT PROFILE ALONG ℄ OF CREST



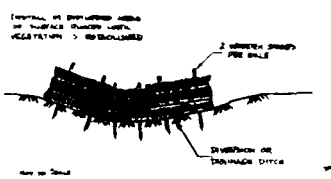


TYPICAL ROADWAY CROSS SECTION

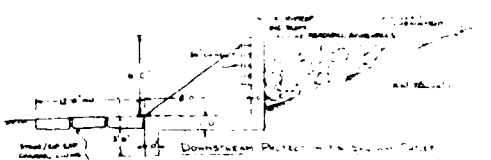




SECTION A GRAVEL TRENCH DRAIN

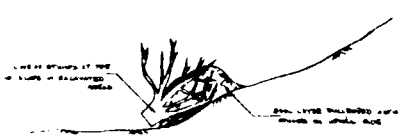


HAYBALE CHECKDAM

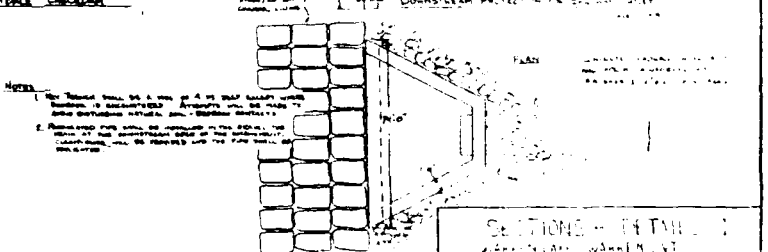


DOWNSTREAM PROTECTION

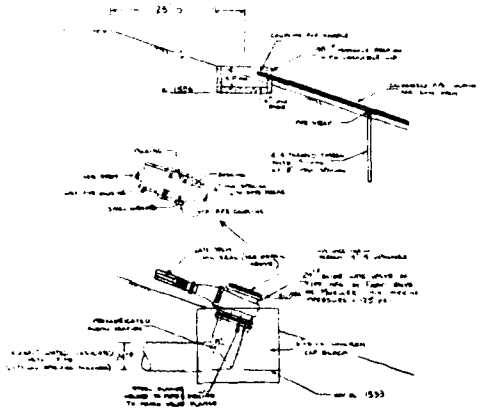
EROSION CONTROL DIKE



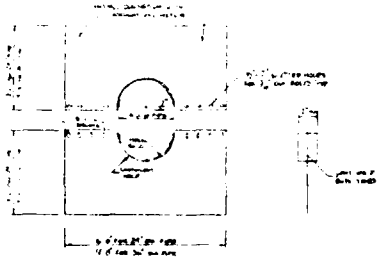
STRAW AND EARTH SILT FENCE

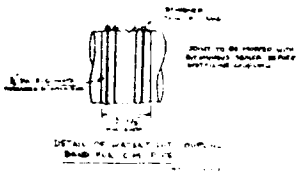


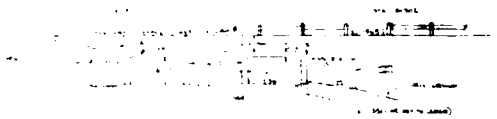
SECTIONS AND DETAILS

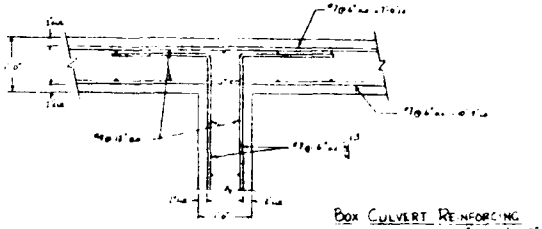


Detail of Emergency Drain Valve

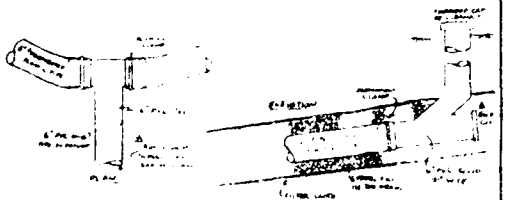


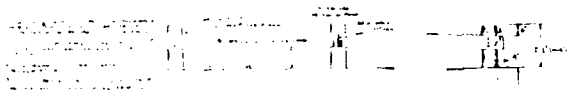


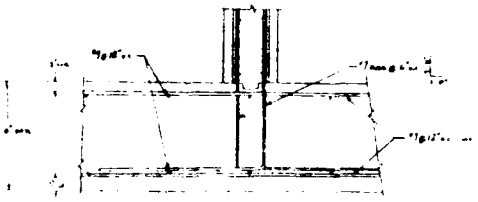




Box Culvert Reinforcing

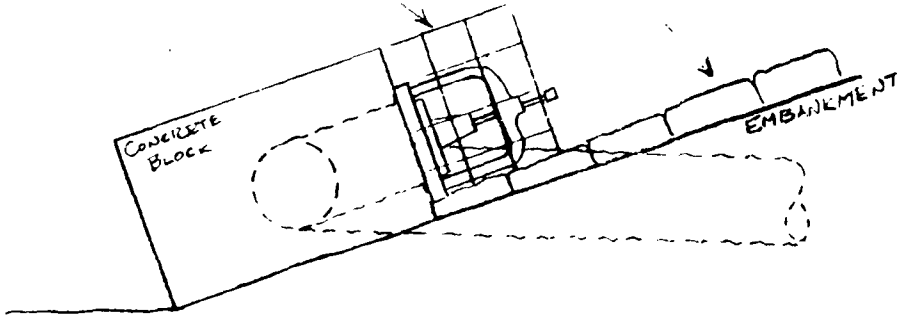




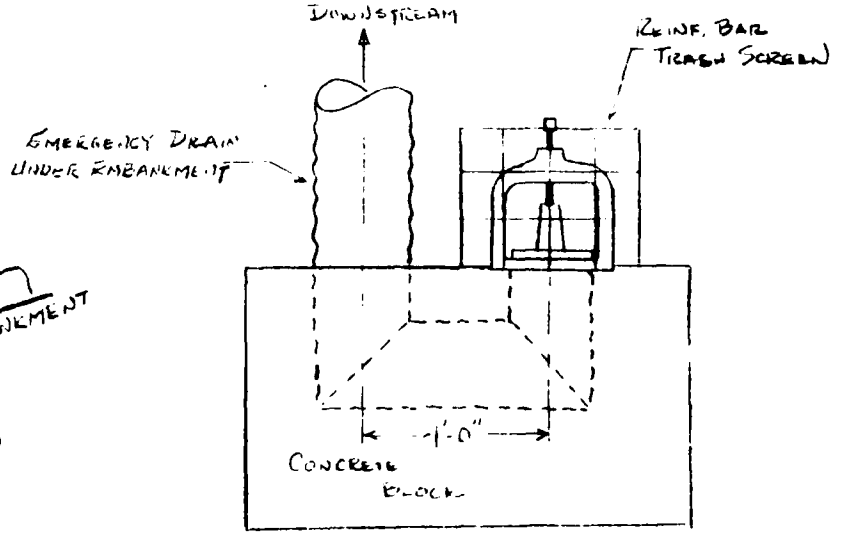


4A

NOTE: KIP-RAP SLOPE PROTECTION SHALL MEASURE 10 FT. BY 10 FT. MIN AREA WITH STONES BEING AT LEAST 2'x2'x 0'-8" EACH.



SIDE VIEW



PLAN VIEW
SCALE 1"=4'

WARREN LAKE - WARREN, VT.

J. KEIR AND L. ROBINSON

JUNE 30, 1980

JAMES P. OLSON, P.E.
HINESBURG, VERMONT

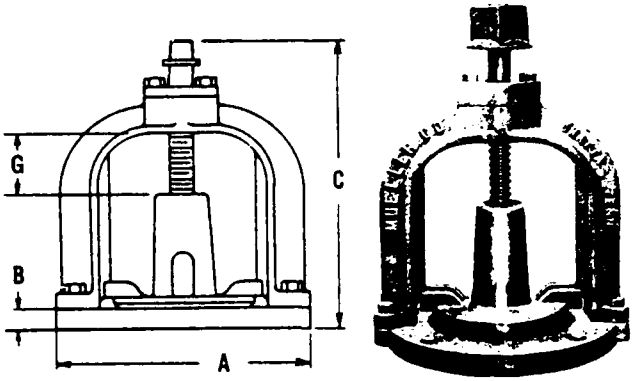
4A
REVISION

IRON BODY BRONZE DISC RING SEAT RING AND STEM

MUD or PLUG DRAIN VALVES NON-RISING STEM

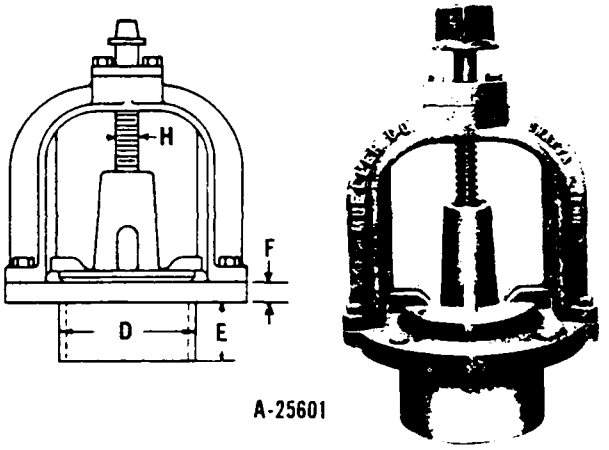
Regularly furnished with 2" square wrench nut. Furnished with handwheel, extension stem or extension stem and floor stand when specified (Pages 24-13 and 24-14).

A-25600: Flanged Frame
Non-rising Stem
Sizes: 3", 4", 6", 8", 10", 12", 14", 16", 18", 20", 24"



A-25600

A-25601: Spigot Frame
Non-rising Stem
Sizes: 3", 4", 6", 8", 10", 12", 14", 16", 18", 20", 24"



A-25601

Dimensions In Inches

Size	A	B	C	D	E	F	G	H
3"	7½	¾	11⅜	3¾	4-6-9-12	⅞	1¾	1
4"	9	15/16	14¾	4⅞	4-6-9-12	1 1/16	1⅞	1⅛
6"	11	1	16⅜	7	4-6-9-12	1⅛	3⅛	1⅛
8"	13½	1⅛	19⅜	9⅛	4-6-9-12	1¼	4 5/16	1¼
10"	16	1 3/16	22⅞	11⅛	4-6-9-12	1 5/16	5⅜	1⅜
12"	19	1¼	24¾	13¼	6-9-12 *	1⅜	6 9/16	1½
14"	21	1⅜	27¼	15¼	6-9-12	1⅝	7⅝	1⅝
16"	23½	1 7/16	29⅞	17½	6-9-12	1 9/16	8 7/16	1¾
18"	25	1 9/16	32¾	19¾	6-9-12	1 11/16	8⅞	1⅞
20"	27½	1 11/16	37	21¾	6-9-12	1 13/16	9⅞	2
24"	32	1⅞	41⅞	25¾	6-9-12	2⅛	12 1/16	2⅜

*Also 18" and 24" Available on 12" Only.

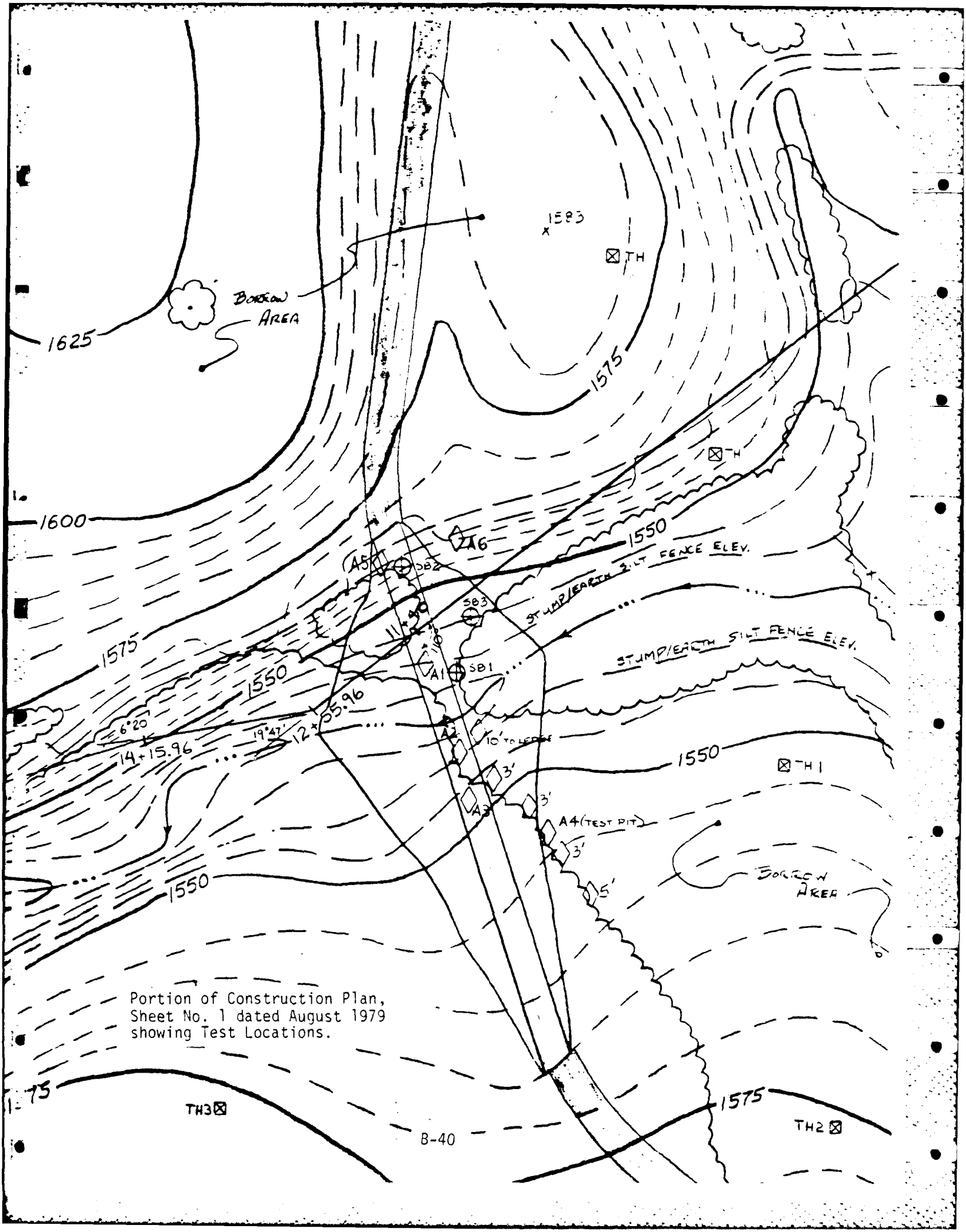
ORDER BY QUANTITY, SIZE, CATALOG NUMBER AND METHOD OF OPERATION.
For A-25601 also specify length of spigot end.

MUELLER CO.
DECATUR, ILL.

TYPICAL BORING LOGS

Location Plan (portion of Construction Plan Sheet No. 1)

Test Borings No. SB-1, SB-2, and SB-3



Portion of Construction Plan, Sheet No. 1 dated August 1979 showing Test Locations.

Green Mountain Boring Co., Inc.

R. D. 2 — BARRE, VERMONT 05641

SHEET 1 OF 3
DATE 10/18/79
HOLE NO. SB 1
LINE & STA.
OFFSET None

TO Lenord Robinson ADDRESS Warren, Vt.
PROJECT NAME Ken Robinson Lake LOCATION " "
REPORT SENT TO Jim Olson PROJ. NO.
SAMPLES SENT TO " " OUR JOB NO. 79-50

GROUND WATER OBSERVATIONS
At 5' at 1 Hours
At ..... at ..... Hours

	CASING	SAMPLER	CORE BAR.
Type		Split spoon	
Size I. D.	2½"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV.
DATE STARTED 10/18/79
DATE COMPL. 10/18/79
BORING FOREMAN Velander
INSPECTOR
SOILS ENGR. Olson

LOCATION OF BORING: Proposed Dam Site

DEPTH	Casing Blows per foot	Sample Depths From — To	Type of Sample	Blows per 6" on Sampler From 0-6	To 6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec.
	10		D									
	15	Used roller rock bit to 8' then bit coring							Woods duff into silty sand & gravel			
	14											
	14											
5'	12											
	19	5' - 6.5'		8	15	24	Damp	5.5'	Medium gravel into silty gray sand	1	18"	18"
	20											
	42											
	63											
10'	89											
	91	10' - 11.5'		33	46	67	Dry		Silty gray sand w/small stone (till)	2	18"	16"
	91											
	96											
	100											
15'	108											
	85	14'-15.5'		43	50	78	Dry		Silty gray sand w/small stone (fine till)	3	18"	18"
	99											
	100											
	114											
20'	119											
		18.5'-20'		11	36	26	Damp		Very fine silt w/sand & trace of clay	4	18"	14"
		Rock at 22', cored 2' of rock										
		RUN #1 22'-24' Recovery 12"							Badily fractured rock (Black carbonaceous shist w/ interbeds of quartzite			

B-41

GROUND SURFACE TO 20' USED 2½" "CASING: THEN 2" core barrel

Sample Type
D = Dry C = Cored W = Washed
UP = Undisturbed Piston
TP = Test Pit A = Auger V = Vane Test
UT = Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb. Wt. x 30" fall on 2" O. D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4	Soft
10-30	Med. Dense	4-8	M/Stiff
30-50	Dense	8-15	Stiff
		30 +	Hard

SUMMARY
Earth Boring 22'
Rock Coring 2'
Samples 4

Green Mountain Boring Co., Inc.

R. D. 2 — BARRE, VERMONT 05641

SHEET 2 OF 3

TO Lenord Robinson ADDRESS Warren, Vt.

PROJECT NAME Ken Robinson Lake LOCATION " "

REPORT SENT TO Lenord Robinson PROJ. NO.

SAMPLES SENT TO " " OUR JOB NO. 79-50

DATE 10/18/79

HOLE NO. SB 2

LINE & STA.

OFFSET

GROUND WATER OBSERVATIONS

At None at 1 Hours

At at Hours

	CASING	SAMPLER	CORE BAR.
Type		Split spoon	2"
Size I. D.	2½"	1 3/8"	Diamond
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV.

DATE STARTED 10/18/79

DATE COMPL. 10/22/79

BORING FOREMAN Velander

INSPECTOR

SOILS ENGR.

LOCATION OF BORING: Top End of Dam North End

DEPTH	Casing Blows per foot	Sample Depths From — To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec.
	5											
	10								Silty sand and gravel w/large cobbles or boulder			
	15											
	20											
5'	100	Refusal on boulder										
	25	Roller rocked through nested boulders to 7'										
	36											
	39								No recovery on spoon appears to be loose gravel			
	44											
	100											
10'	40											
	59	Used roller rock and drilled through nested boulders to 13.5'										
	68											
	89											
	95											
15'	80	14' - 15.5'		51	58	63	Damp		Silty sand w/small stone very hard packed gravel	1	18"	16"
	100											
		Refusal on casing at 16.5'										
		Used roller rock drilled 6" in glacial till onto rock										
	RUN # 1 - 17'-18.5'			8" recovery fractured rock, this could be boulder or bedrock						2	14"	8"

B-42

GROUND SURFACE TO 16.5' USED 2½" "CASING: THEN core barrel

Sample Type

D = Dry C = Cored W = Washed

UP = Undisturbed Piston

TP Test Pit A = Auger V = Vane Test

UT Undisturbed Thinwall

Proportions Used

trace 0 to 10%

little 10 to 20%

some 20 to 35%

and 35 to 50%

140 lb. Wt. x 30" fall on 2" O. D. Sampler

Cohesionless Density

0-10 Loose

10-30 Med. Dense

30-50 Dense

50 + Very Dense

Cohesive Consistency

0-4 Soft

4-8 M/Stiff

8-15 Stiff

15-30 V. Stiff

30 + Hard

SUMMARY:

Earth Boring 16.5'

Rock Coring 1.5'

Samples 2

HOLE NO.

Green Mountain Boring Co., Inc.

R. D. 2 — BARRE, VERMONT 05641

SHEET 3 OF 3
DATE 10/23/79
HOLE NO. SB 2

TO Lenord Robinson
ADDRESS Warren, Vt.
PROJECT NAME Ken Robinson Lake
LOCATION " "
REPORT SENT TO Jim Olson
PROJ. NO.
SAMPLES SENT TO " "
OUR JOB NO. 79-50
LINE & STA.
OFFSET None

GROUND WATER OBSERVATIONS
At Ground at 1 Hours
At at Hours

	CASING	SAMPLER	CORE BAR.
Type		Split spoon	
Size I. D.	2½"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV.
DATE STARTED 10/23/79
DATE COMPL. 10/23/79
BORING FOREMAN Velander
INSPECTOR
SOILS ENGR. J. Olson

LOCATION OF BORING: On Roadway ½ way between SB 1 and SB 2

Depth	Casing Blows per foot	Sample Depths From — To	Type of Sample	Blows per 6" on Sampler From 0-6	To 6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec
	5											
	3											
	10											
	15											
5'	25											
	21	5' - 6.5'	D	25	30	41	Dry		Silty fine sand w/small stone	1	18"	16"
	24											
	30											
	35											
0'	41											
	30	10' - 11.5'		34	46	50	Dry		Silty hard packed sand Hardpan	2	18"	16"
	33											
	33											
	47							12.5'				
15'	51											
	44	15'-16.5'		19	26	45	Damp		Silty gray sand, decayed rock and trace of silt	3	18"	18"
	46											
	46											
	45											
0'	48	19'- 20.5'		15	29	50	Damp		Silty gray fine sand, small stone	4	18"	14"
	43											
	40											
	56											
	56											
25'	75											
	43	25'-26.5'		29	37	42	Damp		Silty gray sand w/small stone (glacial till)	5	18"	16"
	43											
	48											
	52											
0'	59											
		30'-31.5'		40	88	94	Damp		Medium brown sand & decayed rock	6	18"	15"
		Roller rocked to 35' - hit ledge										
		RUN # 1 35'- 37' Recovery 14" ledge							Badly fractured rock Black carbonaceous shist w/ interbeds of quartzite			

B-43

GROUND SURFACE TO 35' USED 2½" "CASING: THEN core barrel

Sample Type
D - Dry C - Cored W - Washed
UP - Undisturbed Piston
TP - Test Pit A - Auger V - Vane Test

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%

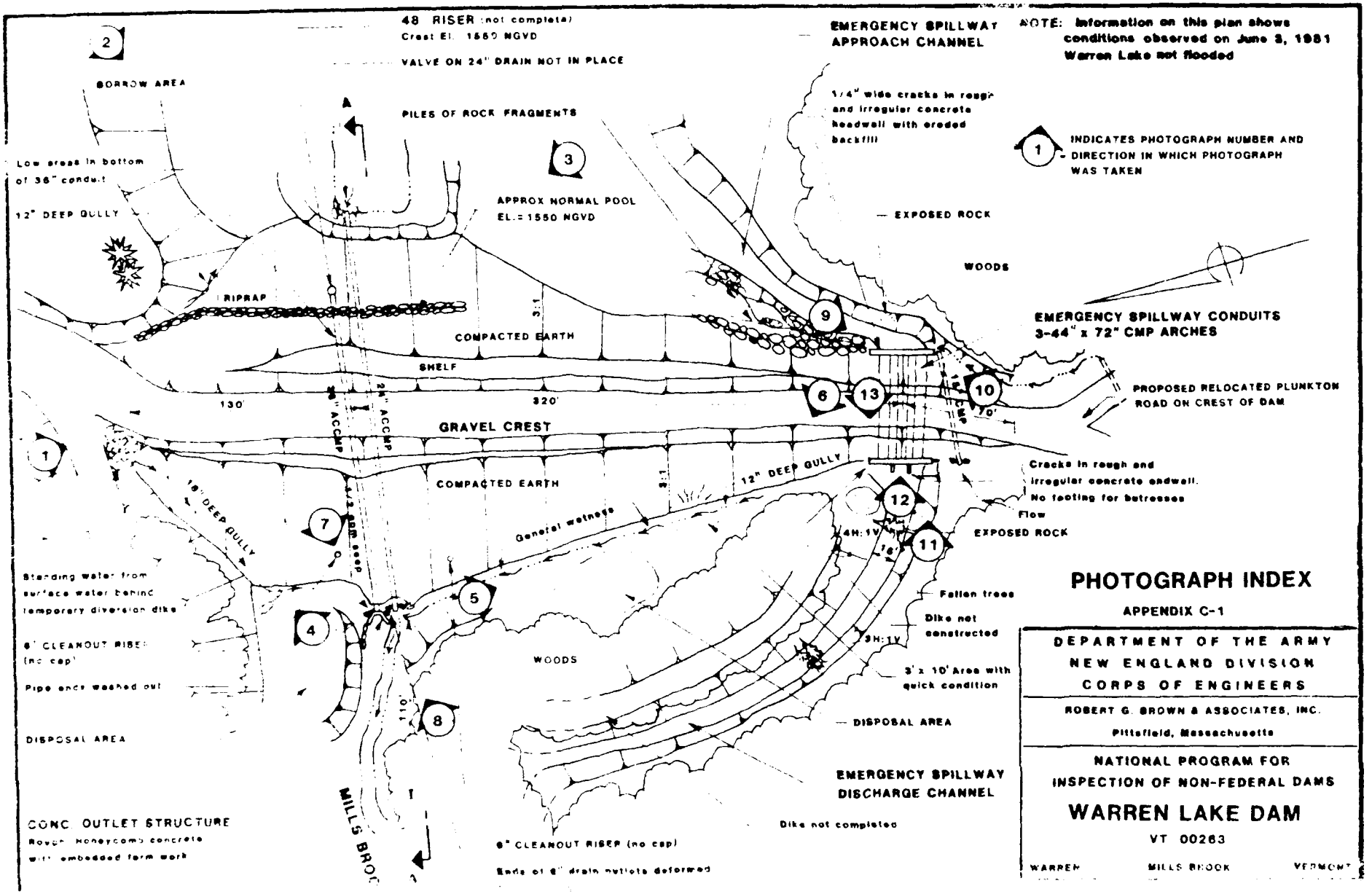
140 lb Wt x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency	
0-10	Loose	0-4	Soft
10-30	Med. Dense	4-8	M/Stiff
30-50	Dense	8-15	Stiff
		30 +	Hard

SUMMARY
Earth Boring 35'
Rock Coring 2'
Samples 7

APPENDIX C

PHOTOGRAPHS



PHOTOGRAPH INDEX

APPENDIX C-1

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

ROBERT G. BROWN & ASSOCIATES, INC.
Pittsfield, Massachusetts

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS

WARREN LAKE DAM

VT 00263

WARREN MILLS BROOK VERMONT

Photograph 1 - Southerly view showing embankment crest and downstream slope. Note standing water and temporary diversion dike at north abutment.

Photograph 2 - View of upstream slope showing riprap and 48-inch riser. Note shelf on upstream slope at approximate elevation 1559 NGVD.

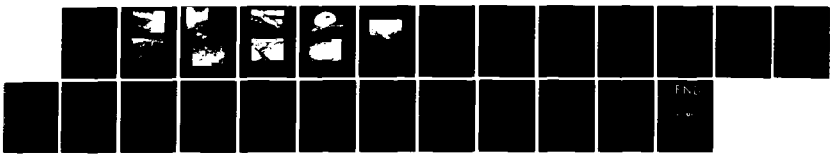
Photograph 3 - View of inlet to 24-incn pond drain at toe of upstream slope and 48-inch diameter riser. Note gully at contact with northerly abutment. Note riprap blanket at normal pool level.

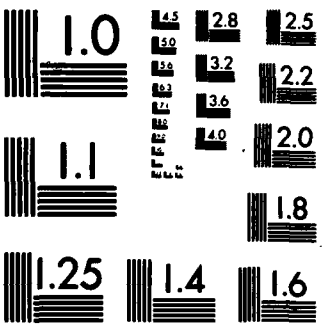
Photograph 4

View of 18-inch deep gully at contact of northerly abutment and downstream slope. Note seepage at lower end of gully and note temporary diversion dike at top of gully.

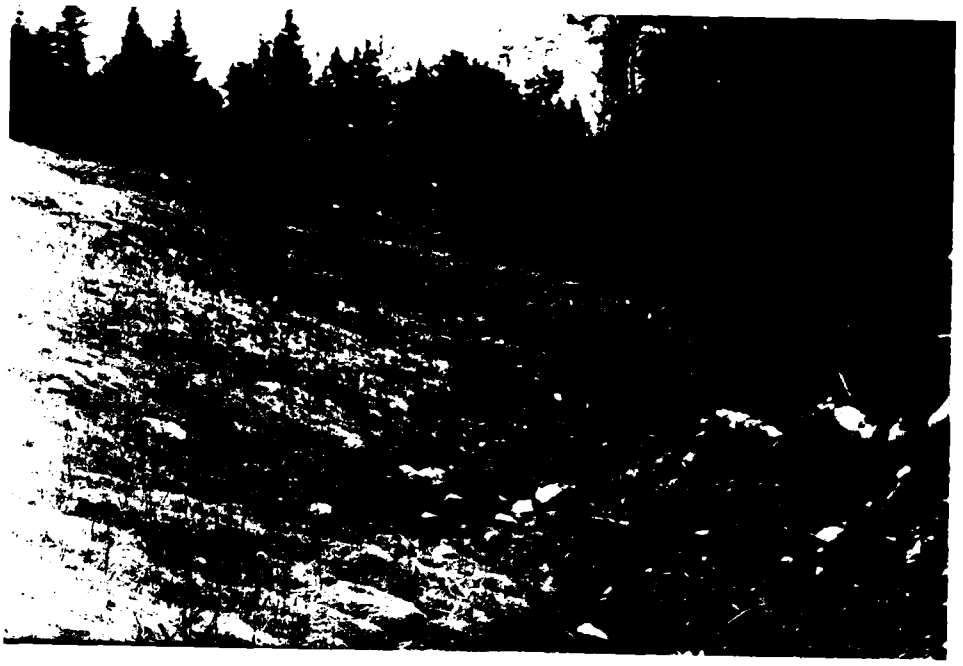
AD-A156 260 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
WARREN LAKE DAM (VT 0... (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV JUL 81

UNCLASSIFIED F/G 13/13 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

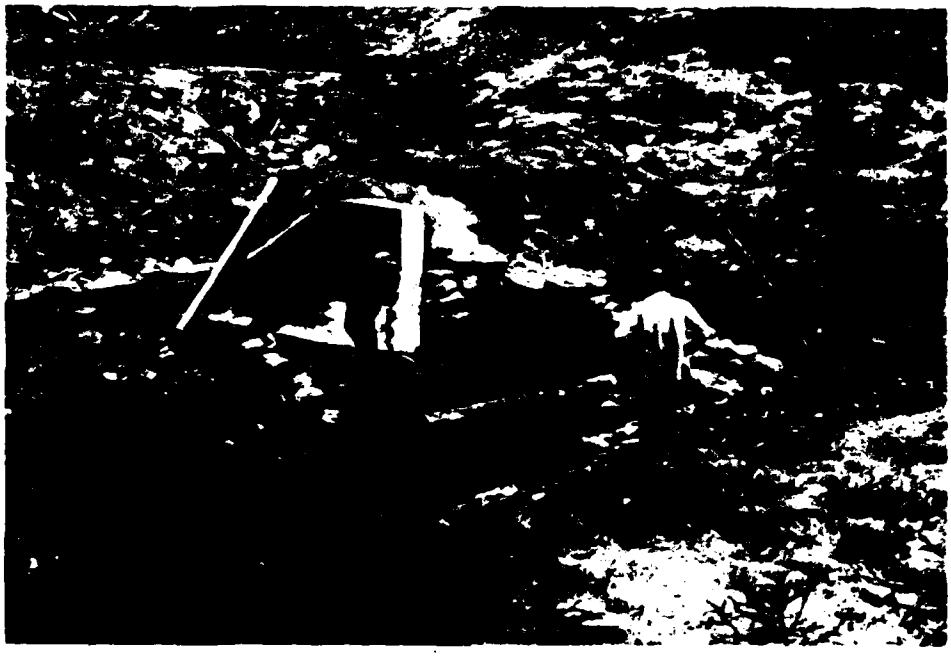


Photograph 5 - View of southerly downstream toe showing general wet condition of toe.

Photograph 6 - View of 3' x 10' area with quick condition at southerly downstream toe.

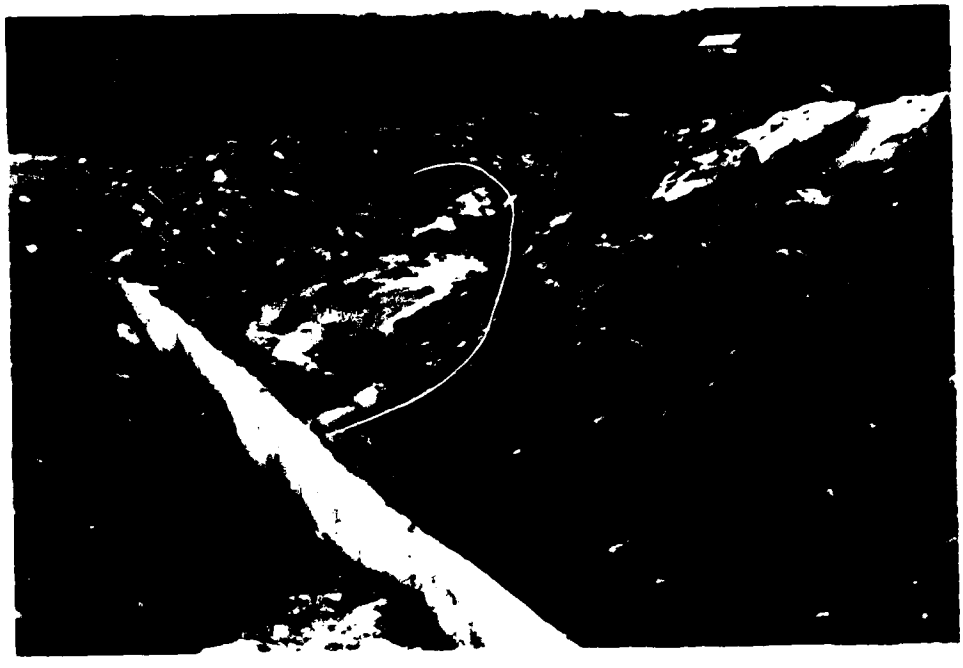
Photograph 7

View of downstream channel. Note washout behind concrete outlet structure for 36" conduit.



Photograph 8 - View of outlets for 36-inch and 24-inch conduits. Note deformed ends of 6-inch drains on each side of the 24-inch conduit. Note washouts at conduit ends. Note embedded formwork in concrete structure.

Photograph 9 - Inlet for emergency spillway showing rough and irregular concrete headwall. Note rock in approach channel.



Photograph 10 - View of emergency spillway approach channel looking upstream. Note irregular concrete headwall with eroded backfill. Also note exposed rock.

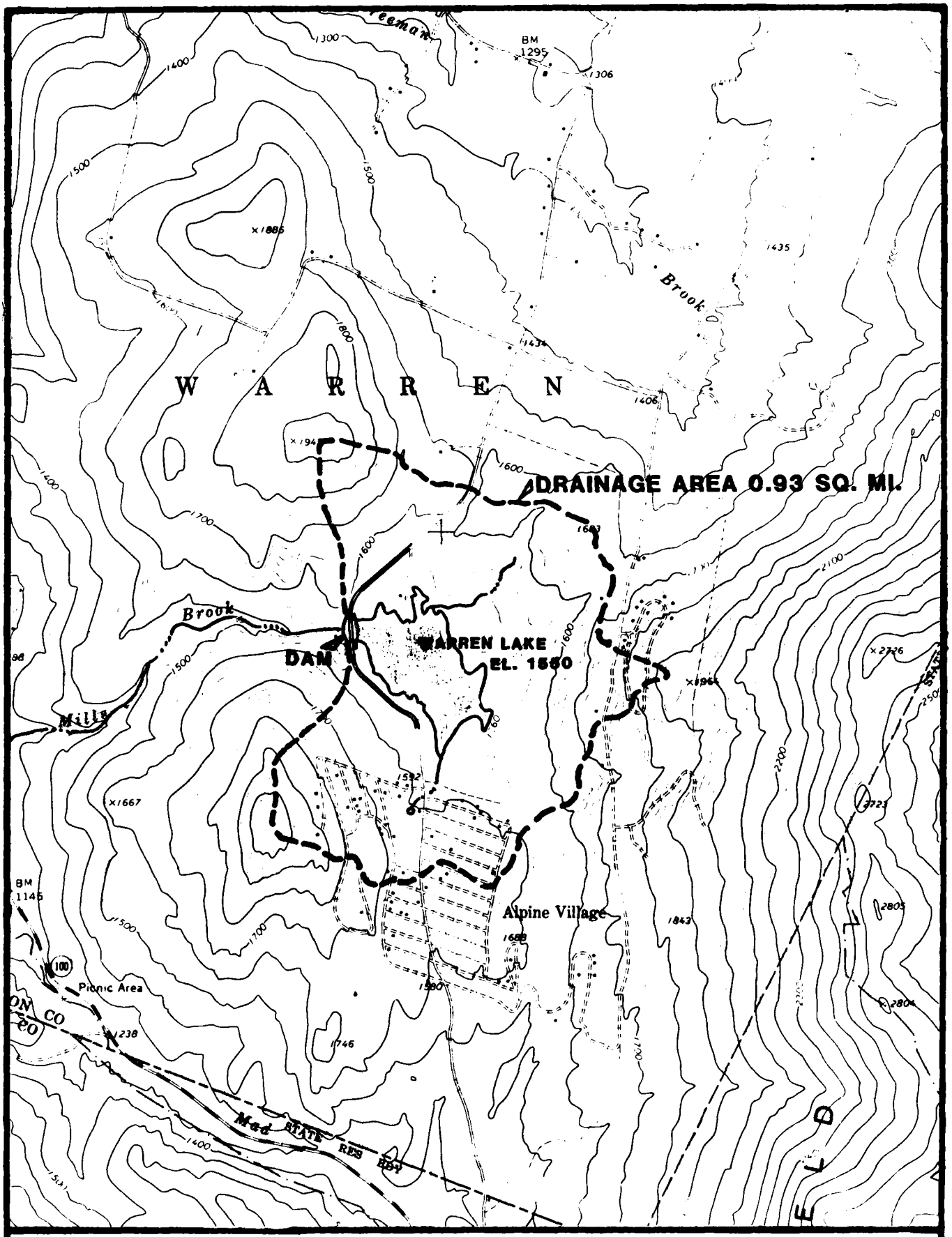
Photograph 11 - Close up of one of three 44" x 72" CMP arch culverts which make up emergency spillway. Note deformation in top of culvert and crack in concrete endwall. Concrete does not surround pipe at bottom.

Photograph 12 - Overall view of emergency spillway outlet. Note cracked, rough, and irregular concrete endwall and buttresses. Buttresses have no footings.

Photograph 13 - Emergency spillway discharge channel looking downstream from culvert endwall. Note exposed rock.

APPENDIX D

HYDRAULIC AND HYDROLOGIC COMPUTATIONS



WARREN LAKE DAM

WARREN, VERMONT

Identification No. VT. 00263

N

APPENDIX D-1

DRAINAGE AREA MAP

Warren Quadrangle

1:24000

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB # 263 Warren Lake Dam
SHEET NO. 1 OF 15
CALCULATED BY JFC DATE 6/23/81
CHECKED BY RGB DATE 7/1/81
SCALE

Step 1 Calculate PMF using "Preliminary Guidance For Estimating Maximum Probable Discharges in Phase I Dam Safety Inspections March 1978

Drainage Area = 0.93 Sq. M. (Planimetered from USGS 1:24000)

Note Ratio $\frac{DA}{Narr\ Dim} = \frac{5.5}{50} = \frac{12}{1}$

Use Curve Value for Mountainous Terrain

CSM_{PMF} = 2500 csm

PMF_{cfs} = 2500 × 0.93 = 2325 cfs

½ PMF = 1165 cfs.

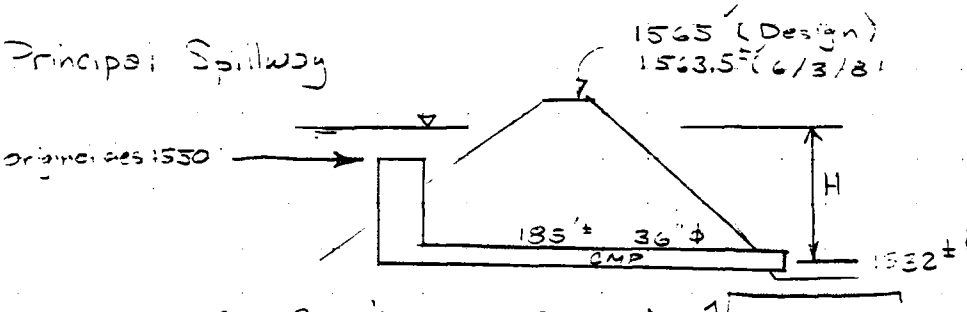
Hazard Class - High
Size - Intermediate
Test Flood - PMF

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB Vt 263 Warren Lake Dam
SHEET NO. 2 OF 15
CALCULATED BY JFC DATE 6/23/81
CHECKED BY [illegible] DATE 7/1/81
SCALE

Step 2a Determine Surcharge Ht. to pass PMF, (also ½PMF)
Assume 24" Ponci Drain is closed
Assume Tailwater at mid-Ht of principal spillway barrel. Assume Principa Spillway riser is clear of debris

Principal Spillway



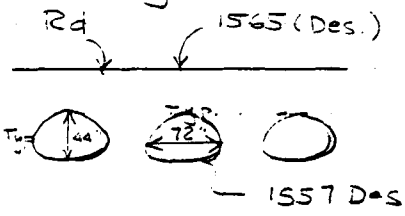
$Q = C_p H^{1/2}$, $C_p = A_p \sqrt{\frac{2g}{1 + k_r \cdot k_p L}}$

$A_p = 7.07\ ft^2$
$k_r = 1.0$
$n = 0.024$
$k_p = 0.0246$
$L = \pm 185$

$$C_p = 7.07 \left(\frac{2 \times 32.2}{1 + 1 + (0.0246 \times 185)} \right)^{1/2}$$

$C_p = 22.17$

Emergency Spillway



Rate - Culverts w/ Inlet Control
Ke = Headwall (from table 5)
Ref. SCS Exhibit [illegible]

Note - E.S. Discharge Channel is designed for max of about 1' depth of flow per design engineer. Present discharge channel is not completed.

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

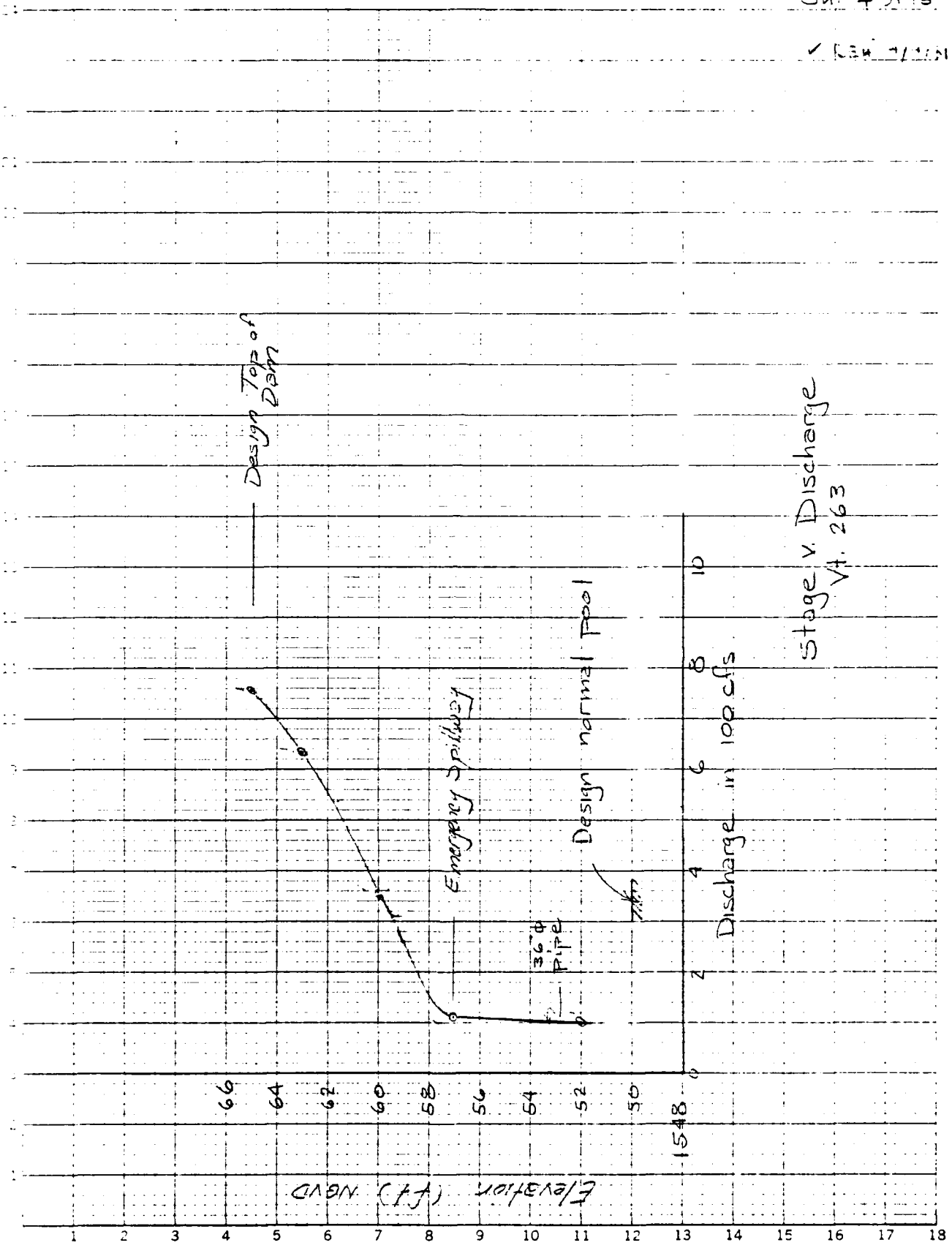
JOB Vt. 263 Warren Lake Dam
SHEET NO 9 OF 15
CALCULATED BY JFC DATE 6/22/21
CHECKED BY [illegible] DATE [illegible]
SCALE

Stage V. Discharge

Note L. Robinson (owner) reports normal pool el may be changed to 1548 (2' lower than design level) There has been no official notice to date of this change. Assume Perm. pool per design at el. 1550

Elev	Principal Spillway Flow H	H' = Dep. normal	Cp	Q pool	Emergency Spillway Flow h_w (see note →)	h_w/D	q	Q_{EM}	Q TOTAL
1550									
1552	20'	4.97	22.17	99.1					99'
1554	22	4.61		104.0					104'
1557	25	5.00		110.9	0				111
1560	28	5.21		117.3	3	0.32	76'	228	345'
1562	31	5.57		123.5	6	1.63	170'	510	634'
1565	33	5.79		127.3	8	2.18	210	630	757'

$D = \frac{49"}{12} = 3.67'$


Stage v. Discharge
Vt. 263
Design Top of Dam
Emergency Spillway
Design normal Pool
36" Pipe
Discharge in 100 cfs
Elevation (Ft) NGVD
1548
66
64
62
60
58
56
54
52
50
0
2
4
6
8
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB V- 263 Warren Dam
SHEET NO 5 OF 15
CALCULATED BY JFC DATE 3/23/
CHECKED BY [illegible] DATE 1
SCALE

Stage vs. Storage

El.	Surf Ac.	ΔV	ΣV
540	25		
1550	48	360	360
1560	110	770	1130
1565	150	650	1780

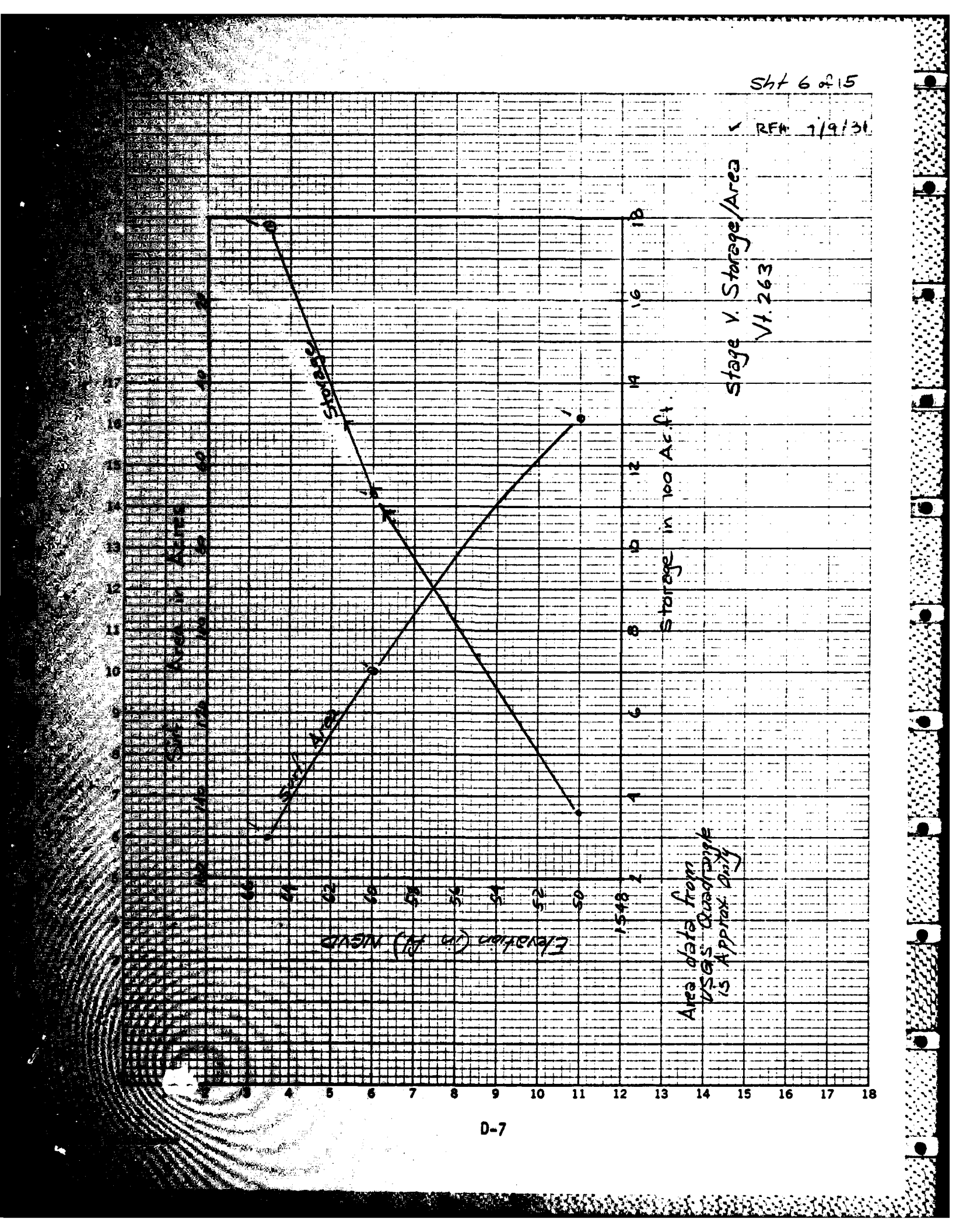
Ac by planimeter from USGS Contours

$$\Delta V = \tfrac{1}{3} h \left[b_1 + b_2 + \sqrt{b_1 b_2} \right]$$

b_1 = [illegible] surface
b_2 = enlarged [illegible] surface
h = [illegible] between [illegible] two [illegible]

At El. 1548 use Normal Storage
360 AF − (45 Ac × 2') = 270
1550

RFH 7/9/31


Stage V. Storage/Area
Vt. 263
Storage in 100 Ac.ft.
Elevation (in ft) MSVD
Storage
Area
Area data from
USGS Quadrangle
is Approx. Only

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB Vt. 263 Warren Lake Dam
SHEET NO. 7 OF 15
CALCULATED BY JFC DATE 6/24/31
CHECKED BY [illegible] DATE [illegible]
SCALE PMF - Short Routing

Vol of PMF Runoff ~~for~~ New England ≈ 19"
Vol = $\frac{19}{12}$" × 595 Ac = 942 Ac. ft. < storage at top of dam
Q_{P_1} = 2325 cfs

With Normal Pool of 1550

Assumed Q_{out}	Stage	Surch Storage Ac ft	Stor" above 1550	$Q_{P_2} = Q_{P_1}(1 - \frac{Stor"}{19})$	$Q_{P_2} - Q_{out}$
350	1560	770	15.53'	424'	75'
410	1560.5	840	16.95'	250'	-160'
375	1560.2	800	16.14'	350'	-25'
360	1560.1	790'	15.94'	375'	15' OK

Use 1560.2

Normal Storage 360 Ac ft

$Stor" = \frac{Surch\ Stor(Ac\,ft) \times Sq\,Mi \cdot in}{53.3\,Ac\,ft} \times \frac{1}{0.93\,Sq\,M.}$

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB MT 263 Warren Lake Dam
SHEET NO. 3 OF 5
CALCULATED BY RSH DATE 7/9/81
CHECKED BY _____ DATE _____
SCALE _____

SUMMARY (WITH NORMAL POOL AT EL. 1550')

PMF TEST FLOOD INFLOW	2325 CFS
ROUTED PMF TEST FLOOD OUTFLOW	360 CFS
PMF TEST FLOOD ELEVATION	1560.2 NGVD
STORAGE AT TEST FLOOD ELEV.	1150 Ac-Ft
SURFACE AREA AT TEST FLOOD ELEV.	110 Ac
ELEVATION OF TOP OF DAM:	
Design	1565.0 NGVD
(As-Built 6/3/81	1563 ± NGVD)
STORAGE AT TOP OF DAM ELEV.	1780 Ac-Ft
SURFACE AREA AT TOP OF DAM ELEV	150 AC

SPILLWAY CAPACITY AT TOP OF DAM ELEV: % TEST FLOOD

Principal Spillway	127 CFS	35%
Emergency Spillway	630 CFS	175%
Total	757 CFS	210%

Robert G. Brown & Associates, Inc.
Berkshire Common - Third Floor North
PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB Vt 263 Warren Lake Dam
SHEET NO 9 OF 15
CALCULATED BY JFC DATE 6/29/01
CHECKED BY [illegible] DATE [illegible]
SCALE

Breach Analysis

Assume breach width W_b = 40% of crest length at mid-ht

$$W_b = 260' \times 0.4 = 104'$$

Assume breach occurs with water at El 1560.1 Level of routed test flood (PMF) starting at normal pool of El. 1550.

S = Storage at 1560.1 = 1150 Ac-ft

$$Q_p = 8/27\ W_b \sqrt{g}\ y_o^{3/2}$$

y_o = ht from stream bed to pool level at failure

y_o = 1560.1 - 1530 = 30.1'

$$Q_p = (8/27)(104)(32.2)^{1/2}(30)^{3/2} = 28{,}732 \text{ cfs}$$

Add spillway flows prior to breach

360 cfs
29,092 cfs
say 29,000 cfs = breach Q

Antecedent Discharge - 360 cfs
(Principal & Emergency Spillway Flow)

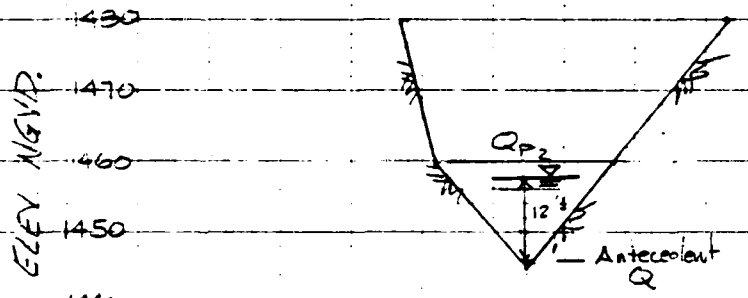
MILLS BROOK 2500' DS OF DAM

SFH 7/9/91

X-SECT FROM USGS QUAD.

1" = 400' H

(LOOKING U/S)

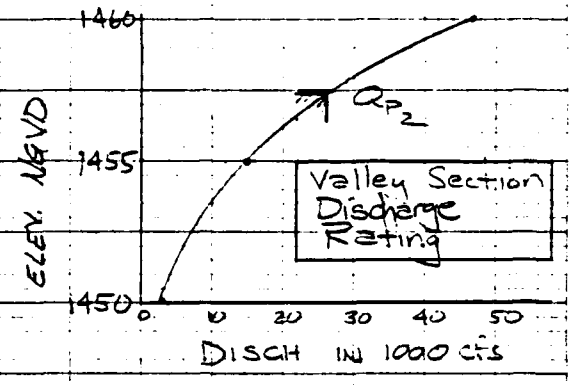


$n = 0.07$

$S_o = 40/1100 = 0.0364$

$Q = \frac{1.4^{\circ}}{n} A R_H^{2/3} S_o^{1/2}$

EL.	Area ft²	W_P ft	R_H ft	Q_{cfs}
1550'	375'	150'	2.5'	2814'
1560	3000	400	7.5'	46995
1555	1250	250'	5.0	14923'



Attenuate Breach

$Q_{P_2(Trial)} = Q_{P_1}\left(1 - \frac{V_1}{S}\right)$

$V_1 = 2210 \frac{ft^2 \times 2500 ft}{43560} = 127$ Ac ft

$= 29000\left(1 - \frac{127}{1150}\right) = 25800$ cfs

$V_2 = \frac{1890 \times 2500}{43560} = 108$ Ac ft

$V_{Ave} = \frac{108+127}{2} = 118$ Ac Ft

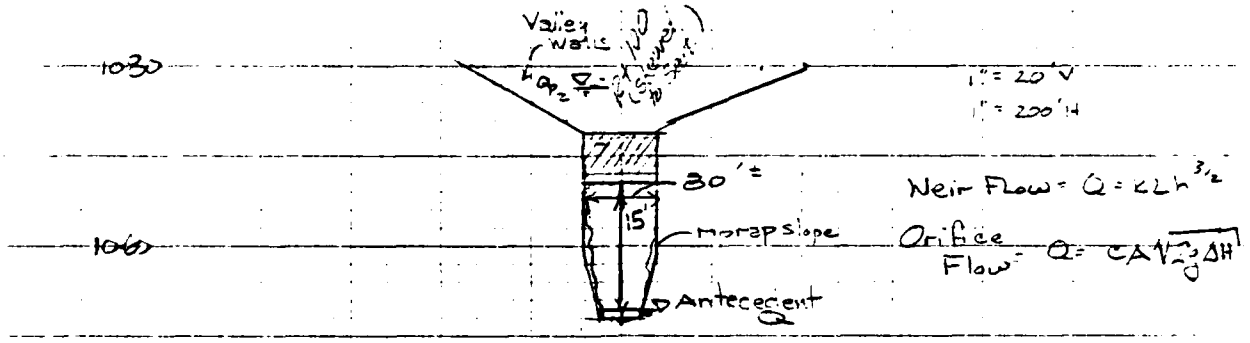
$Q_{P_2} = 29000\left(1 - \frac{118}{1150}\right) = 26{,}000$ cfs

Note

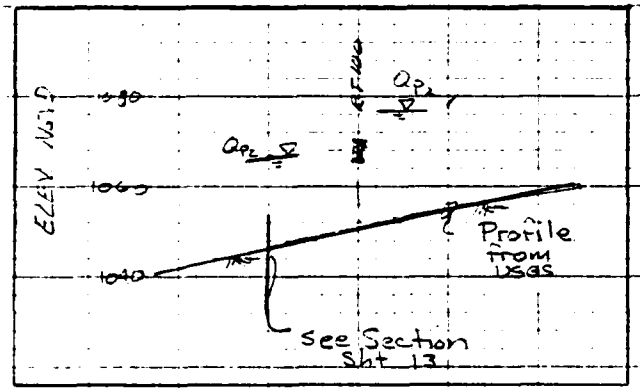
Below this point the stream channel for Mills Brook steepens and Valley narrows - no significant storage areas to attenuate breach - Enters Mad River 6000 D/S of Dam

JFS 9/27/91

RT 100 BRIDGE OVER MAD RIVER
8300' D/S OF DAM



Depth U/S Bridge	ORIFICE FLOW THRU BRIDGE ΔH	C	Q	WEIR FLOW OVER BRIDGE K	L	h	Q	Q_{TOT}
20'	5'	0.7	10,677					
27	12'	"	16,540	3.0	200	7	11,112	27,652 ←

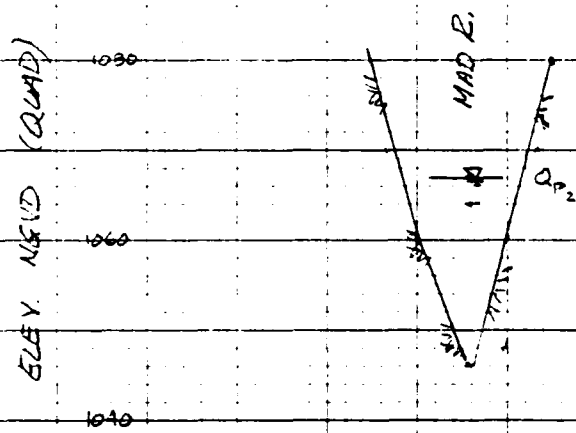


APPROX. CHANNEL PROFILE AREA OF RT 100 BRIDGE

NOTE - 2-3 STRUCTURES IN AREA OF BRIDGE COULD BE FLOODED ESTIMATED 2-3 ANTECEDENT FLOWS WOULD BE ABOUT 20' BELOW LEVEL OF STRUCTURES

WATER COULD BE HIGHER IF BRIDGE OPENING OBSTRUCTED

VALLEY SECTION 200' DS. OF RT 100 BRIDGE / 9500' DS OF DAM.

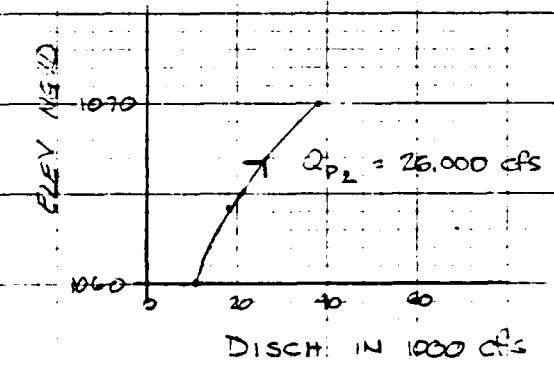


$$Q = 1.49 \frac{A R_H^{2/3} S_o^{1/2}}{n}$$

$n = 0.05$

$S_o = \frac{20}{1000} = 0.02$

	DEPTH	Area (ft^2)	W_p (ft)	R_H (ft)	Q (cfs)
1060	14'	700'	105'	6.67'	10,519'
1064	18'	1080'	130'	8.31'	18,305'
1070	24'	1800'	160'	11.25'	38,395'



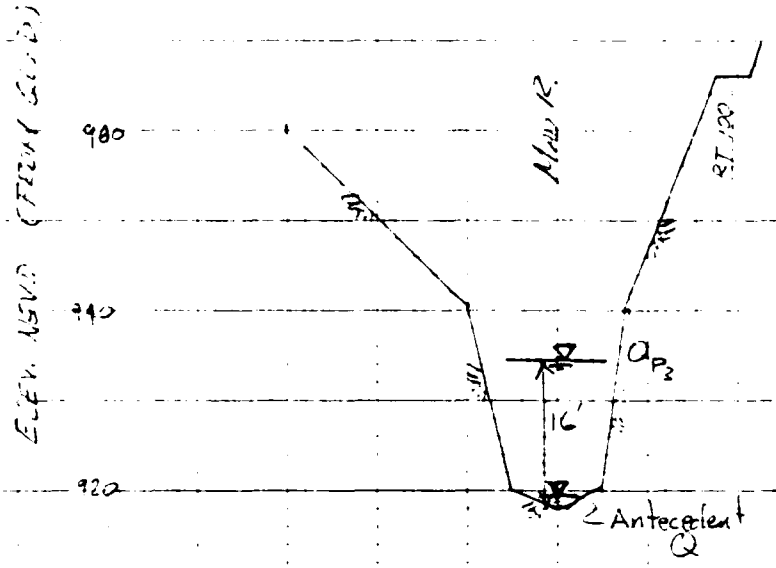
Note
Little Valley Storage in this reach - Steep Valley walls & Narrow Floor Plain

Sht 13 of 15

CFH 11/1/51

VALLEY SECTION 15,700 DS OF DAM

(LOOKING DS)



1" = 20'V
1" = 200'H

$Q = \frac{1.49}{n} A R_w^{2/3} S_o^{1/2}$

$n = 0.05$

$S_o = \frac{20'}{2520} = 0.0071'$

	Depth (ft.)	Area (ft²)	W_p (ft)	R_w (ft)	Q (cfs)
930	12'	1300'	160'	9.12	13,280
945	22'	2900'	210'	13.81	42,284
935	17'	2050'	180	11.39	26,271

$Q_{P_2} = 26,000$ cfs

$V_1 = 2100 \cdot \frac{3200}{43560} = 154$ Ac-ft

Flood Plain Storage

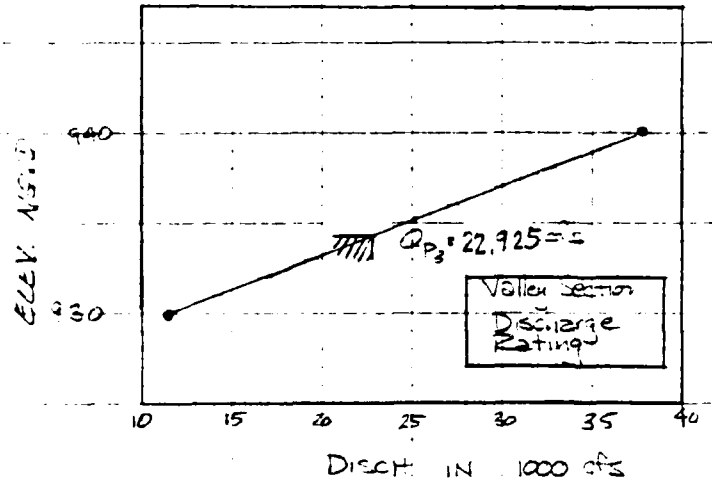
$Q_{P_3}(\text{Trial}) = Q_{P_2}\left(1 - \frac{V}{S}\right)$

$Q_{P_3}(\text{Trial}) = 26,000\left(1 - \frac{154}{1150}\right) = 22,722$

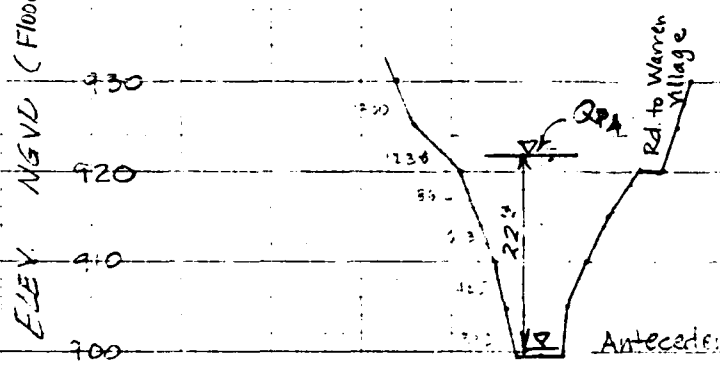
$V_2 = \frac{1850 \cdot 3200}{43560} = 127$ Ac-ft

$V_{ave} = \frac{154+127}{2} = 36$ Ac-ft

$Q_{P_3} = 26,000\left(1 - \frac{136}{1150}\right) = 22,925$



VALLEY SECTION - SOUTH END OF WARREN VILLAGE, 18,000' D/S OF DAM
(400' D/S OF RT 100 BRIDGE)
(LOOKING D/S)



* Cross Section Plotted from 1" = 200' S.C.T. Topo prepared for Warren, VT Flood Insurance Study by Anderson-Nichols. Preliminary work Map dated Sept. 27, 1975.

Antecedent 2

Start backwater area from DS Timber Crib dam.

$n = .040$ DS.

$S_o = \frac{0.7}{300} = 0.0023$

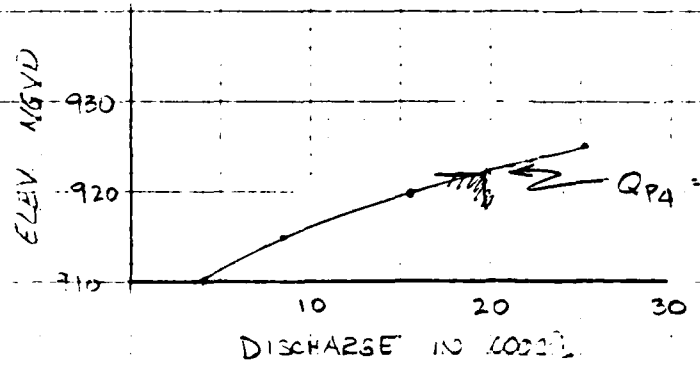
$Q = \frac{1.49}{n} A R_H^{2/3} S_o^{1/2}$

	Depth	Area	W_p	R_H	Q
910	10.5'	755'	105'	7.19'	4046
915	15.5'	1368	155'	8.82	8407
920	20.5'	2230	210'	10.62	15,520
925	25.5	3518	320'	10.99	25,052

Use V_{ave} =

$\frac{2200 \times 2200}{43560} \times 100$ Ac-ft

$Q_{P_4} = 22925 \left(1 - \frac{100}{1150}\right) = 20931$ cfs



Note- There are about 10 to 12 structures (Covered bridge) in Warren Village which could be overtopped by 2 to 3 feet of water as a result of dam failure. Water prior to dam failure would be about 5 feet below the roadway.

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PITTSFIELD, MASSACHUSETTS 01201
(413) 499-1560

JOB Vt 262 Warren Lace Dam
SHEET NO 15 OF 15
CALCULATED BY JFC DATE 5/30/13
CHECKED BY _____ DATE _____
SCALE _____

Conclusions on Downstream Hazard

1. Breach flow would enter the Mad River 6000' downstream of dam. Due to the narrow valley section on Mills Brook there would be only minor attenuation of the breach flow before reaching Mad River (See Sht 11).

2. Approximately 2300' downstream of the confluence of Mills Brook, the Mad River crosses under Rt 100 beneath a steel stringer bridge. (This bridge and 2 others could be damaged or destroyed as a result of a major breach.) There are 2 to 3 structures in the area of the RT 100 bridge which could be flooded to a depth of 2 - 3 feet. Antecedent flows would be about 20' below the structures prior to the breach. (See Sht. 12)

3. Approximately 18000 feet downstream of the dam the breach flow would begin to pass through the village of Warren. There are about 6 structures in the village (+ Covered bridge) which could be flooded to a depth of 2 to 10 feet. Antecedent flows would be about 10 feet below lowest structure. There is a small timber crib dam which could cause higher water levels if it withstood the breach. (See Sht. 15)

D-16

4. Because of the potential for damage due to impact and flooding and because of the potential for loss of more than 3 few lives in this area - dam is classified High HAZARD.

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

END

FILMED

8-85

DTIC